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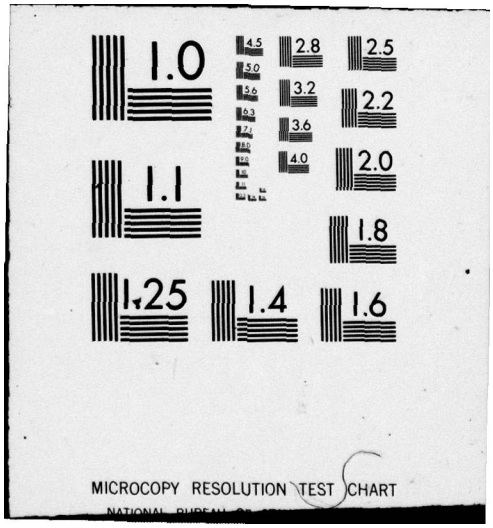
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ANNUAL PROGRESS REPORT
FISCAL YEAR 1978

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Reported by
Stanley C. Knapp, Col, MC
Commanding

AL A082072

30 July 1979

U.S. ARMY AEROMEDICAL RESEARCH LABORATORY
FORT RUCKER, ALABAMA 36362

USAARL

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Unclassified

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(17) ØØ

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Annual Progress Report FY 78

THIS REPORT

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Conducts fundamental and applied research on the medical aspects of Army aviation, airborne and ground operations that affect the health, welfare and efficiency of the soldier; perform medical research on visual/auditory functions; man/machine integration; the medical aspects of non-medical material; physiological/psychological response to the operational environments; and military training impacts upon ecology. Provides technical advisory and consultant services to all elements of Department of Defense and other government agencies in support of helicopter, combat crew and airborne medicine.

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Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Foreword

The U.S. Army Aeromedical Research Laboratory (USAARL) is a Class II Medical research laboratory of the U.S. Army Medical Research and Development Command (USAMRDC), Office of The Surgeon General. USAARL is a tenant organization at the United States Army Aviation Center, Fort Rucker, AL.

The USAARL was initially established to accomplish research in support of the Army Aviation community and airborne activities. Additional specific mission areas were added to the laboratory and transferred at the closing of the Fort Knox laboratory and are reflected in the mission statement. The laboratory's mission has expanded even further in recent years to include the assessment of the medical impact of advanced armor and aritillery weapons systems and other nonmedical material.

The U.S. Army Aviation Center, with its large concentration of human and equipment resources, provides our laboratory personnel with an ideal environment to remain abreast of Army Aviation developments, and other related activities. In turn we can provide the expertise early on in the development stages as well as provide immediate and direct support to deal with problems that may arise.

Other activities concerned with aviation research and development are in close proximity to USAARL. Together these organizations form the U. S. Army Aviation Center Team. This team includes the U.S. Army Safety Center, the Army Aeromedical Center, the U.S. Army Aircraft Development Test Activity, the U. S. Army Research Institute Field Unit, DARCOM Program Managers and TRADOC Systems Managers, the U.S. Army Aviation Board and the Directorate for Combat Developments.

USAARL additionally maintains close liaison with aviation medicine research laboratories of other U.S. Armed forces as well as those from the civilian community. Assistance and Cooperative efforts with the Naval Aerospace Medical Research Laboratory at Pensacola, Florida; the U.S. Air Force School of Aerospace Medicine, Brooks AFB, Texas; FAA Civil Aeromedical Institute, Oklahoma City, Oklahoma; the Night Vision Laboratory, Fort Belvoir, Virginia; the U.S. Army Research and Technology Laboratories, Moffett Field, California and with many other agencies enhance the research efforts of all the agencies concerned.

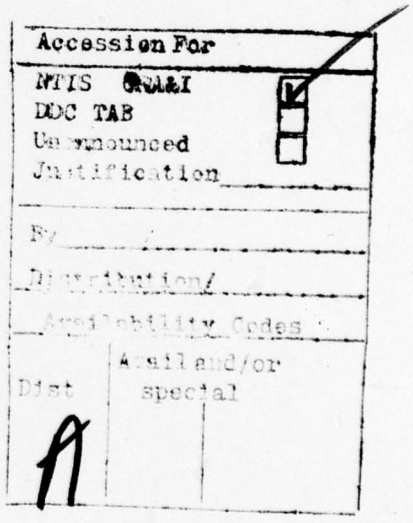
USAARL also maintains close coordiantion with foreign governments of NATO countries, on aviation medicine matters, through its involvement with the Advisory Group for Aerospace Research and Development (AGARD), a NATO organization.

The overall research effort of the U.S. Army Aeromedical Research Laboratory (USAARL) has two general objectives: enhancement of individual soldier and combat crew performance and efficiency, and prevention of injury and/or death in the military operational environment. USAARL accomplishes these objectives through identification, investigation and solving of medical and health related problems not only associated with aviation and airborne activities, but also to combat land vehicles and their crews and other combat weapons systems and environments as directed. Most of our research falls within the broad areas of physiological optics; the psychophysiologic aspects of combat crew workload and performance; biomechanics of closed, direct head trauma; the psychophysiology and physics of acoustics and communication and the clinical, orthopedic and biomechanical effects of long term vibration on the musculoskeletal system.

USAARL's research is recognized internationally by the operational and aeromedical communities. The men and women at USAARL take pride that their work is predicated on the needs of the soldier, and that the answers and solutions provided are relevant and timely to the operational needs of soldiers.

US ARMY AEROMEDICAL RESEARCH LABORATORY
ANNUAL PROGRESS REPORT
1 Oct 77 - 30 Sept 78

MISSION: Conducts fundamental and applied research on the medical aspects of Army aviation, airborne and ground operations that affect the health, welfare and efficiency of the soldier; perform medical research on visual/auditory functions; man/machine integration; the medical aspects of non-medical material; physiological/psychological response to the operational environments; and military operational training impacts upon ecology. Provides technical advisory and consultant services to all elements of Department of Defense and other government agencies in support of helicopter, combat crew and airborne medicine.



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RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0D 6734	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DIS'B'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
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10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162773A819	00	055
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)
(U) Direct Field Research Support to Immediate Army Aeromedical Problems

12. SCIENTIFIC AND TECHNOLOGICAL AREAS
001300 Aircraft; 006000 Escape Rescue and Survival; 013300 Protective Equipment

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
64 06	CONT	DA	C. In-House

17. CONTRACT/GRANT
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b. NUMBER:
c. TYPE: N/A d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	7.0	56.5
FISCAL YEAR CURRENT 79	6	368.4

19. RESPONSIBLE DOD ORGANIZATION
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TELEPHONE: (205) 255-5107

21. GENERAL USE

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TELEPHONE: (205) 255-3211/6504
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Johnson, J., CPT
NAME: Slobodnik, B., LT

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Life Support Equipment; (U) Protective Equipment; (U) Accident Investigation; (U) Blood Pressure Measurement; (U) Injury Costs

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide biomedical criteria for improved Army life support equipment, develop conceptual designs of new equipment including monitoring equipment for the acutely injured.

24. (U) Epidemiologic methods incorporating engineering failure mode analysis, accident investigative procedures, forensic pathology, mathematical modeling, and bioengineering techniques to integrate hardware with the biologic requirements of man.

25. (U) 77 10 - 78 09 The biomedical research support to the field has been made in four major areas; the Life Support Equipment (LSE) Retrieval Program; the design of a noise and vibration immune inflight blood pressure monitor (IBPM); biomedical aspects of ground vehicle operation; and helmet damage/head injury correlation. LSE was analyzed using newly developed documentation techniques. Data obtained is applicable to ADP methods and will be used for LSE design optimization. Hardware and control software for the IBPM nears completion. Instrumentation has been assembled for correlation of flow signals with blood pressure. Close coordination with the Product Manager-Combat Vehicle Technology (PM-CVT) has been maintained. Investigations into physiological effects of high level vibrations in ground vehicles have been proposed. Recommendations have been made to PM-CVT on ways to minimize medical hazards in advanced vehicle designs. Significant results were found when head injury was correlated with helmet (SPH-4) damage. Concussion was shown to occur in A/C accidents at levels of impact well below the 400 g QA acceptance limit for the SPH-4 helmet. Research continues in all of the above areas.

MILITARY RELEVANCY CERTIFIED UNDER SECTION 204 (FY ____ FUNDS)
BY William K. Crowston

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498

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Life Support Equipment Retrieval Program (LSERP)

Statement of the Problem:

Life Support Equipment (LSE) involved in aircraft accidents is subjected to its ultimate test with human subjects under actual field conditions. Until November 1971, this equipment was not formally being evaluated to insure it was providing the injury protection for which it was intended. Improvements in life support equipment had, therefore, been made on a subjective and haphazard basis.

Description of the Project:

AR 95-5 requires the president of an air craft accident investigation board to send all pieces of life support equipment involved in either injury causation or prevention to USAARL for biomedical and injury correlation evaluation. This evaluation assesses the life support equipment and the related human dynamics involved in the accident. Pathology data from the Armed Forces Institute of Pathology (AFIP) is integrated as appropriate. The results of this failure mode analysis and impact damage simulation testing provides a sound basis for establishing life support equipment design criteria and recommendations for product improvement.

Progress, Status and Results:

During the past year, 89 accident reports were reviewed which resulted in the retrieval of the life support equipment from 14 accidents. A photographic system was developed for reproducible documentation of damage seen in helmets retrieved from aircraft accidents. A system of overlays has been designed which, in conjunction with the documentation photographs, provides us with a means of assigning grid coordinates to helmet damage locations. This system is being used to build a data bank of helmet impact damage information. Such information in usable form is invaluable in evaluating the adequacy of current helmet designs. In many cases an Equipment Improvement Request (EIR) is submitted based on the findings of the LSERP. In the case of an OH-58 crash, an EIR was submitted to strengthen the rear lap belts in the OH-58 aircraft. The EIR was a direct result of an LSERP case involving the failure of rear lap belts in the OH-58.

Impact tests of specific retrieved helmets was continued. These tests are being conducted to attempt the correlation of helmet damage to head injury. The ultimate goal of this damage simulation is a better definition of human tolerance to head impact. Initial results, based on the damage simulation of 14 helmets, indicates that the current industry-wide design and test criteria for crash helmets needs some critical changes. For example, the currently

accepted headform deceleration of 400 G results in a relatively "stiff" helmet which causes unconsciousness in many crashes. Since this laboratory has demonstrated experimental helmets which cause a deceleration of only 150 G (at equal energy levels), it is concluded that the design and test criteria for helmets could and should be changed.

Papers Published:

None

Papers to Scientific Journals:

None

SPH-4 Damage and Head Injury Correlation

Statement of the Problem:

Significant head injury contributes 25% of the total major impact related injuries in Army light aircraft and helicopter accident injuries. This figure has changed very little over the past ten years, even though crash protective helmets have been issued and used by aircrewmen. It is evident that the impact protection offered by current protective headgear is inadequate. However, efforts to develop new helmet design criteria have been unsuccessful due to the current inadequate understanding of human tolerance to head impact. If human tolerance limits to head impact could be defined, headgear could be designed which would be effective in preventing head injuries from occurring in survivable aircraft accidents. The objective of this study is to establish what human tolerance limits to head impact are.

Description of the Project:

Much of the currently available data on human tolerance to head impact have been generated from animal studies or from cadaver data. In either case, the dynamics of the impact and the material properties of the head are different from those which would be encountered in a similar experience using a living, breathing human being. However, the risk involved in conducting such studies on human subjects is prohibitive. This study takes advantage of the data which is produced during the crash of an aircraft in which crewmembers sustain head injury. Such an accident provides us with: (1) a damaged helmet, and (2) a medical description of the physiological damage sustained by the head. From the condition of the helmet (i.e., shape and depth of impact damage) it is possible to determine the magnitude and vector direction of the impact to the head. This is done by subjecting a new helmet to an impact on a drop tower in which the damage may be duplicated under controlled conditions. The impact is electronically monitored to determine peak acceleration, severity index, head injury criterion and transmitted force. These physical data are then correlated with the severity of the head injury sustained as indicated in the medical report of the accident victim.

Progress, Status and Results:

The data collected from the impact damage simulation of the 14 cases duplicated to date were statistically analyzed. The following conclusions were reached:

Concussive head injuries occurred below the Head Injury Criterion value of 1000. These values are used as the concussive threshold by the National Opeating Committee on Standards for Athletic Equipment and the Department of Transportation respectively.

Peak transmitted force proved to be the best predictor of the severity of head injury. It may be a more valuable criterion to use in evaluating helmet impact performance than is peak G. These results are being prepared for publication in the Journal of Aviation Space and Environmental Medicine and were presented at the Advisory Group for Aerospace Research and Development (AGARD) Medical Panel meeting held 6 - 10 November 1978 in Paris, France. The process of helmet damage simulation and head injury correlation continues as more helmets become available. Additional data will be collected until an accurate predictive scale of head injury may be established.

Papers Published

Slobodnik, B. and Nelson, W. Science Life Analysis of the SPH-4 Aviator Helmets, Aviation Space and Environmental Medicine. November 1977, 48, 1058-1067.

Papers to Scientific Journals

Slobodnik, B. and Treanor, J. SPH-4 Helmet Damage and Head Injury Correlation, Aerospace Medical Association Annual Scientific Meeting, New Orleans, LA May 1978.

Biomedical Aspects of Ground Vehicle Operation

Statement of the Problem:

The development and use of advanced concepts in ground vehicles can pose additional stresses on vehicle crewmembers. It is the objective of this program to determine the nature and severity of those biomedical stresses and to coordinate biomedical research with program managers involved in ground vehicle development.

Description of the Project: It was requested by the US Army Tank and Automotive Research and Development Command through Medical Research and Development Command that this laboratory provide biomedical consultation on the development of new tracked vehicles. In response to this requirement, USAARL submitted a number of applicable scientific research topics to the Program Manager, Combat Vehicle Technology (PM-CVT). USAARL provided biomedical consultation to PM-CVT at numerous meetings during the development cycle of the High Survivability Test Vehicle (Lightweight) (HSTV(L)). This vehicle employs a semireclining seat which allows the direct transmission of vehicle vibrations to the head of the crewmember. The effects of these vibrations are currently unknown, but must be established prior to the fielding of such a vehicle. The possibility of physiological trauma to the head and the possibility of noise and vibration interaction in producing hearing loss should not be ruled out without further study. Since this vehicle incorporates sophisticated fire control electronics and a video display, the effect of high amplitude vibration on crewmember ability to control this system and read the video monitor should be determined.

Progress, Status and Results:

USAARL input to the source selection process for the HSTV(L) was instrumental in ruling out the possiblity of a prone seat in that vehicle. A review of the HSTV(L) mockup provided the PM with several possible product improvements. Several of these were implemented by the manufacturer. Five investigators who are assigned to work on this program attended an orientation course in armor operations and training. A study to determine the effects of vibration on man's ability to use a video display while seated in a supine or reclining seat was planned and tentatively approved by the PM-CVT. Funding to conduct that project never materialized. USAARL has continued to support the biomedical data requirements of the Program Manager, Combat Vehicle Technology, with in-house funding.

Papers Published:

None.

Papers to Scientific Journals:

None.

Automated In-Flight Blood Pressure Monitor

Statement of the Problem:

In-flight monitoring of blood pressure in patients transported by helicopters cannot be done using conventional blood pressure monitoring techniques.

Description of the Project: The vibration and noise levels in rotary wing aircraft operation negate the usual BP measurement techniques procedures of employing a stethoscope and a BP cup secured around an extremity. A method which is applicable in the helicopter environment must be found so that blood pressure monitoring within the aircraft or ground ambulance can be accomplished in a practical manner. Furthermore, it is necessary to develop a system which is automated in order to free medical personnel for patient stabilization and other emergency health care procedures which may be required by other patients aboard the medical evacuation vehicle. A system is desired which continuously monitors the blood pressure of the patient and which will sound an alarm should this blood pressure fall outside normally acceptable limits. Without this blood pressure information, the well-being of the patient may be compromised. If the information is available, prompt treatment will allow these individuals to arrive at their ultimate medical destination in a condition better able to withstand the medical rigors which awaits them. One dedicated microprocessor and peripheral digital and analog signal conditioning equipment will be used to operate the automated blood pressure monitor. A doppler ultrasonic blood flow monitor will be used in conjunction with an occulusive cuff to determine the systolic and diastolic blood pressure values. Noise immunity and vibration immunity will be gained by analog filtering and digital pattern recognition techniques.

Progress, Status and Results:

Numerous commercially available blood pressure devices have been field tested in a UH-1 helicopter. None of the devices tested have functioned properly in that environment. The method for determining systolic and diastolic blood pressure from ultrasonically monitored blood flow signals has been developed. However, a correlation study intended to validate the technique against standard ausculatory techniques has not yet been completed due to the temporary absence of medical personnel from the laboratory. Programming of the microprocessor controller for the monitor is progressing smoothly. Approximately 40 software routines have been written and debugged to perform functions which include display, control sequencing and measurement. Hardware to perform the cup inflation and deflation has been constructed, interfaced to the controller and sucessfully tested. Additional circuitry for doppler ultrasonic flow signal processing and pressure recording has been constructed and is undergoing testing.

Papers Published:

None.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0D 6735	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 12 15	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162773A819	00	015
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code)

(U) Research of Bioengineering Problems Medically Significant to Army Aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 002400 Bioengineering; 023300 Protective Equipment

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
66 12	CONT	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	5.0	95.0
	CURRENT 79	4.1	158,900

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory

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RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, CDR

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab
Human Tolerance & Survivability Div

ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME: Slobodnik, Bruce, LT

TELEPHONE: (205) 255-3001

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME:

NAME:

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Helmet Testing; (U) Injury Prevention; (U) Protective Equipment; (U) Burn Prevention; (U) Porcine Burns; (U) Head Protection; (U) Bioengineer

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide valid, meaningful biomedical criteria for the development of improved designs and equipment for head protection, the means to assess helmet protective performance, and prevention of post crash fire burn by improved thermal protective clothing.

24. (U) The approach will be based on sound and accepted experimental bioengineering methodologies including mathematical modeling, pathophysiologic techniques, biomechanics structural engineering, thermo dynamics, and physics.

25. (U) This work unit supports the Army's designated responsibility for direct head impact work for all three services. Charged to establish a biologically valid helmet test methodology, a major effort has begun to improve head protection in military aircraft accidents. Head injury accounts for 25% of the major injuries and represents the best opportunity for injury reduction. Existing criteria are 15 years old and do not incorporate new materials technologies or injury tolerance levels or injury mechanisms. The last phase (1 year) of development of a biologically valid means to predict human burns from textile laboratory assessments of heat transfer through fabrics is to begin. To achieve this goal will mean development of military clothing to adequately protect soldiers in vehicle fires. Without additional funding, design criteria will not be available for incorporation into the new Army Integrated Aircrew Helmet, for DA decisions regarding replacement of Nomex uniforms with advanced fabrics, or for a new MIL Standard for assessment of protective performance in new helmet procurements. Without the additional direct engineering support manpower, investigators are diverted from research to do maintenance and operational tasks on the complicated tools and equipment necessary to conduct this work thus slowing the project by 40%. This project has unfunded requirements of 2.0 man-years and $32,600. MILITARY RELEVANCY CERTIFIED UNDER SECTION 204 (FY [illegible] FUNDS)

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

Mathematical Model of Thermal Transfer Through Skin

Statement of the Problem:

Thermal protective clothing is required to protect Army vehicular crewmen against fuel fires which sometimes result from crash impacts. Suitable techniques are required in order to evaluate such protective clothing to insure that it provides adequate protection from heat and flame.

Description of the Project:

Although there has been a considerable amount of experimental work done on burn production and on thermal protective clothing, incomplete understanding of the nature of burn production still exists. Because of this, standards relating laboratory test results of thermal protective fabrics to true burn protection afforded by these materials do not exist. To fill this gap in our understanding of burn physiology, a mathematical model is being developed which describes the dynamic physiological factors involved in burn protection. The work is being conducted under contract to the Louisiana State University School of Medicine by Dr. F. S. Knox. An initial computer program using constant parameters of conductivity, density and heat capacity has been written to determine whether or not an iterative method of computation will give accurate answers. This program will also be used to iterate optimal time increment sizes and distance parameters. The program will be expanded to include two dimensions and to include three layers of skin. Results of the model will be validated against burn data as presented by Stoll, Hardy and Knox.

Progress, Status and Results:

Photographic data depicting gross and micrograde of burn have been catalogued. Calculated heat fluxes and exposure times have been added to the data base. Correlation between furnace wall temperature and heat flux for pigs exposed to simulated post-crash fires is underway. In the second version of the program, the analytical model has been developed to take into account water boiling and thermal shrinkage of the skin during the burn process. The revised burn model is now operable, but tends to under-predict shallow burns while overpredicting deep burns. Efforts will continue to refine the models to eliminate these deficiencies.

Papers Published:

None.

Papers/Presentations to Scientific Conferences:

Knox, F. S., "Mathematical Models of Skin Burns Induced by Post Crash Fires as Aids in Thermal Protective Clothing Design and Selection." Army Science Conference, June 1978.

Knox, F. S., T. L. Wachtel, and S. C. Knapp, "Biomedical Constraints on Thermal Protective Flight Clothing Design: A Bioengineering Analysis." AGARD, Fort Rucker, AL, May 1978. Poster Session.

Knox, F. S., "How to Measure the Burn Protective Capability of Nonflammable Textiles: A Comparison of the USAARL Burn Bioassy Technique with Mathematical Models." Fifth International Congress on Burn Injuries, Stockholm, Sweden, Jun 78.

Crashworthy Troop Seat for the Blackhawk (UTTAS) Aircraft

Statement of the Problem:

While the pilot and copilot crew seats in currently fielded Army aircraft provide marginally adequate crash impact attenuation, troop seats in the rear of these aircraft do not. Hence, passengers in rotary wing aircraft may experience injurious or fatal impact loads during survivable crashes. It is the objective of this project to develop a crashworthy troop seat for the new generation of utility helicopter (Blackhawk) being developed by the Army.

Description of the Project:

Current troop carrying helicopter seats do not meet the crashworthy standards available with current technology as outlined in "Crash Survival Design Guide" TR 71-22. Excessive morbidity and fatality rates result during crash sequence. The Blackhawk (UTTAS) is a new aircraft under development as a follow-up to the UH-1. Development of a new crashworthy seat constitutes a major historical landmark as the first full-scale joint medical and engineering effort to develop a safe passenger seat for Army helicopters. A seat design produced by Mr. Joseph L. Haley of USAARL has been completed and incorporates the latest human tolerance and orthopedic design criteria. Prototype seats have been built and testing is underway to determine their ability to absorb impact shock.

Progress, Status and Results:

Initial testing of the forward facing seat revealed an unexpected failure mode in the forward 30 degree yaw test due to the failure of the tie down fittings. These tests were repeated with a modified seat design when the FAA test facility became available in the 2d quarter FY 78. Results of this retest indicated that the commercial floor attachments supporting the seats were inadequate, although the seat itself held together and performed admirably. A final report of the test results is in preparation.

Papers Published:

None.

Papers to Scientific Journals:

None.

Tolerance of the Human Head to Impact on the Crown

Statement of the Problem:

It appears from field data that impacts to the crown of the SPH-4 helmet during aircraft accidents causes unnecessarily high rates of concussion in aviators. It is postulated that the crown region of the helmet may be too stiff and transmit excessive forces to the crown of the head.

Description of the Project:

Little is known about the specific mechanism of head injury involved in impacts to the crown region of the head. Because of this, there is insufficient design data with which to optimize the impact attenuating properties of the crown region of protective headgear. In this project human cadavers will be impacted in the crown area of the head. The impact velocity will be 20 feet per second and minimum input energy will be 300 foot lbs. Impact forces will be measured using a load cell while skull deformation is to be recorded using high speed color film and pulse x-ray. The helmet used to protect the skull will be an Army SPH-4 aviator helmet. Once the dynamics of the impact to the head are established the design of the SPH-4 may be optimized to minimize the possibility of concussion due to impact in the crown region of the head.

Progress, Status and Results:

This is a new project which is currently unfunded. The test plan for the study has been written and coordinated with authorities in the field of head injury. It is expected that when funding is received, data gathering will commence soon thereafter.

Research of Impact and Noise Attenuating Crashworthy Helmet Earcup

Statement of the Problem:

The current earcups mounted in the SPH-4 helmet provide adequate sound attenuation and hearing protection but do not provide impact attenuation during crashes. The objective of this project is to develop a crushable earcup which will provide sufficient impact attenuation.

Description of the Project:

The earcups currently mounted in the military SPH-4 aviator helmet are constructed of solid plastic and are suspended from the helmet by elastic straps. Hence, the combination of hard plastic earcups and fiberglass shell does not provide any degree of impact attenuation during lateral impacts to the head which may be experienced during an aircraft accident. Furthermore, the configuration of the earcup which may be likened to a cookie cutter can produce high levels of localized stress during lateral head impacts. To alleviate this problem, it was decided to develop an earcup which would deform during lateral head impacts and absorb energy during the crash. The ability of the earcup to deform under load precludes the development of localized stress on the skull and provides for more uniform distribution of the lateral impact forces.

Progress, Status and Results:

Because the ability to fabricate earcups from crushable materials is not available within the laboratory, specifications were written to delineate the size, shape, impact attenuation properties and acoustical properties of the required crushable earcups. Subsequently, a contract was let to Simula, Inc., of Tempe, Arizona. The feasibility of two possible earcup materials was described in a preliminary report from the contractor. Two earcup concepts which they presented stand out -- polyurethane or polyethylene foam construction and secondly, convoluted aluminum bellows structure. Protypes of these groups have been manufactured and have been delivered to USAARL. Tests, both acoustic and impact, on these earcups indicate that a corrugated aluminum earcup best meets the performance specifications spelled out in the contract. Based on these results, a contract was negotiated with Simula, Inc., to produce a corrugated aluminum earcup suitable for installation in a SPH-4 helmet. A report of these tests is planned for publication during the first quarter of FY 79.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DAOE6733	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
771215	H. Termination	U(No CH)	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	61101A	3A161101A91C	00	287
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)* (U) Research of Bioengineering and Vibration problems medically significant to Army aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

001300 Aircraft; 002400 Bioengineering; 015600 Solid Mechanics

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
74 07	Cont	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:* N/A
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	2.4	67
	CURRENT 79	0	0

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Research Lab

ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: KNAPP, Stanley C., COL, CDR

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Lab
Bioengineering & Life Spt Equip Div

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* ERHARDT, Thomas M., SP5

TELEPHONE: (205) 255-7112

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: JOHNSON, John C., CPT, MS

NAME: HALEY, Joseph L., GS-14

21. GENERAL USE

22. KEYWORDS (Precede EACH with Security Classification Code)

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To determine the short-term clinical effect of helicopter vibration on the musculoskeletal system and to develop an orthopaedically, anthropometrically sound helicopter crew seat to reduce vibration effects.

24. (U) Prospective clinical and epidemiologic study using physical examination subjective reporting forms, Norland Bone Mineral analysis, biochemistry, and x-ray techniques. Seat design and validation will be accomplished statically and dynamically on a three degree of freedom, man-rated vibration table using dynamic EMG techniques. Pilots performance and efficiency are studied. Animal models are used and the techniques of tetracycline bone labeling and scanning electron microscopy of the joint surfaces are employed.

25. (U) FY 78 ILIR funds have enabled the completion of the project entitled "Bone Mineral Density Changes Due to Physical Stress." The report of the results of the project involving 150 subjects was presented to the Aerospace Medical Convention in New Orleans in May. The vibration exposure of animals on the Multi-Axis Helicopter Vibration Simulator (MAHVS) has been completed. This exposure consisted of 1 g at 5-20 Hz of either sinusoidal or white noise vibration for 1½ hours per day, 5 day per week, for 6 months. The experimental and control animals have been sacrificed and all samples have been successfully obtained. The synovial fluid and blood samples are undergoing biochemical analysis. The limb joints have been examined throughout the exposure period using acoustical methods and the data is being analyzed by the computer. These same joints will also be examined by Scanning Electron Microscopy techniques and Light Microscopy and cross sections of the long bones will be examined under Fluorescent Microscopy to determine bone growth rate differences with the aid of fluorescent bone labels. Project terminated due to unfunding.

*Available to contractors upon originator's approval.

DD FORM 1 MAR 66 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.

Biodynamic Evaluation of Protective Headgear

Statement of the Problem:

Head injuries resulting from impact accelerations during the crash of an aircraft or a ground vehicle result in injury or death to a significant number of military personnel. The objective of this program is to design, develop and validate headgear concepts and evaluation methods to meet the need for head protection of Army aviators and of soldiers in the field.

Description of the Project:

It is essential that protective headgear be designed and evaluated to insure that it provides maximum state-of-the-art protection for the soldier. This implies: first, that suitable criteria exist for the determination of helmet suitability; and second, that suitable test methods exist with which to determine the ability of a helmet to protect against impact. Until recently, the test methodology set forth in ANSI-Z90.1 has been used by this laboratory in testing helmets; however, Z90.1 was generated for road user helmet testing. Crash situations within the Army differ from those experienced by the general road user. Hence, USAARL has the responsibility of analyzing test methods which consider the unique aspects of the military environment and evaluating the biodynamic aspects of head injury causation as related to the design of military protective helmets. USAARL currently has mission authority for the conduct of quality assurance evaluation on all Army helmets in order to insure compliance with medical and protective performance criteria.

Progress, Status and Results:

Several new test methods have been evaluated in this laboratory. The Z90.1 method requires determination of the peak acceleration imparted to the metal headform during impact through a helmet. This peak acceleration level is sensitive to numerous mechanical pecularities in the drop tower system. In order to reduce the possibility of erroneous acceleration readings, a forced transducer was mounted between the reaction mask and the helmet impactor. From this transducer, a check on the peak G sensed by the accelerometer is made. In addition, the use of a forced transducer enables USAARL to compare its drop tower data directly with that of British investigators who generally prefer the transmitted force measure to that of induced acceleration. In support of Development Test II of the Personnel Armor System for Ground Troops (PASGT), a study was conducted to determine the impact attenuation properties of the PASGT Infantry helmets, both before and after a period of field testing. Results of the study indicated a deterioration in the energy absorbing properties of the foam nape pad used in the PASGT para-trooper helmet. A recommendation was made that the energy absorbing nape pad used in the PASGT para-trooper helmet be constructed with a material exhibiting stress strain properties similar to those of the M-1 standard

nape pad throughout the expected shelf-life of the item. With this restriction in effect, the PASGT helmets exhibited shock attenuation comparable to the standard M-1 helmet. A report was published on the helmet structure temperatures experienced by a helmet during impact testing under Z90.1 conditions. Results of the study indicate that cold conditioning as required by Z90.1 does not simulate real world conditions, but produces inverted temperature gradients by comparison with actual cold use data. Quality assurance assessment of the DH-132 combat vehicular crewman helmet continues. Contractual basic research into the dynamic material properties of the central nervous system continued at Tulane University under USAARL sponsorship. A finite element simulation model of the helmet headform system by Auburn University is in preparation. Over 8,500 helmet impacts have now been recorded digitally for computer analysis in the helmet drop data file. These impacts represent both experimental drops and impacts from quality assurance helmets tested during the past six years. In this usable form, such data is a valuable resource for future helmet design and modeling.

Papers Published:

Current, J., After Wear Impact Evaluation of the Personnel Armor Systems for Ground Troops (PASGT) Helmets. USAARL LR 78-7-3-1, January 1978.

Haley, J. and T. Hundley. Effects of Helmet Construction on Impact Energy Attenuatio , presented at the Aerospace Medical Association Annual Scientific Meeting, New Orleans, LA May 1978.

Current, J., Biomedical Evaluation of the Standard M-1 and Candidate Personnel Armor System for Ground Troops (PASGT) Helmets-Secondary Injury Evaluation. USAARL 78-1, October 1978.

Papers to Scientific Journals:

None.

Army-Air Force Vibration Study

Statement of the Problem:

Pilots of rotary wing aircraft develop back pain as a result of flying rotary wing aircraft. It is the objective of this program to determine the effects of helicopter vibration on bone growth dynamics and to investigate the possibility of damage to joint surfaces attributable to vibration.

Description of the Project:

A recent study of 128 pilots disclosed that 87.5% suffered from back pain, generally, after 300 hours of flying time. The average figure cited in this study, indicates that the threshold of appearance of pain occurs when one flys 4 to 5 hours per day, 40 to 50 hours per month. In this program, two methods were used to determine whether or not this pain was due to pathological changes in bones or joints. In the first study, a group of new aviators was compared to a non-flying control group. The groups were observed to determine the existence of any vibration related bone changes. In the second study, miniature swine were used as a model for studying the effects of vibration on a skeletal system before classical radiological changes were present. Tetracycline bone labeling techniques were used in the later study to determine bone growth measurements and scanning electron microscopy was used to identify joint surface damage.

Progress, Status and Results:

The clinical study of aviators versus nonaviators indicated a higher degree of bone mineral density change and stress fracture in the recruits during basic training which were used as a control group. The aviatior group which was studied did not fly sufficient hours to make this test truly valid. However, because of the unusual changes in recruits, it was decided to study the effect of basic training on production of stress fracture and bone mineral density changes. The principle finding of this later study is that within the 150 femal voluntary company that underwent the most strenous training, an increase in bone mineral density of the ulna was observed. Of all other factors considered, there was no significant temperal effect on bone mineral density; although factors such as age, race, hand dominance and birth control did have some effects. In the animal study, the bone labeling techniques employed were tested and found to produce excellent quality flourescent rings with both decaf and tetracycline using intravenous and intramuscular administration. The eight miniature swine used in the project were sacrificed. Blood and synovial fluid samples were drawn, various bones and adrenal glands were removed and a gross necropsy was performed. The x-ray analysis of limb joints have shown no gross

anomolies. Other data is still awaiting analysis. Flourescent labeled bone and joint surfaces will be analyzed by electron and light microscopy. Blood and synovial fluid samples are being analyzed for various biochemical fractions realted to possible vibration induced arthritic changes.

A detailed handbook for the MultiAxis Helicopter Vibration Simulator entitled, "MultiAxis Helicopter Vibration Simulator Operations and Service Manual," has been written for the vibration facility by Mr. John M. Jenkins.

Papers Published:

Gearhart, J., T. Earhardt and E. Altekruse. Bone Mineral Density Changes Due to Physical Stress, presented at the Scientific Meeting Aerospace Medical Association, New Orleans, LA, May 1978.

Orthopedic VSTOL Aircrewmember Seat Design

Statement of the Problem:

Aircrew members experience moderate to severe back pain during prolonged flight of rotary wing aircraft. The objective of this project is to develop and validate an orthopedically sound helicopter crew seat which reduces involuntary anti-gravity muscle activity in the dynamic environment.

Description of the Project:

Two possibilities exist which may contribute to the development of back pain in crewmembers of rotary wing aircraft. One is the development of pathological changes in the spine due to vibrational effects and the second is the response to vibration of musculature supporting the torso and head. Muscular stress problems are compounded by the poor posture which aviators must maintain in order to maintain fine control touch on the helicopter controls. During the initial design phases of this project, it was determined that further analytical data was required in order to pinpoint the physiological source of this problem (osteopathic or myopathic). Furthermore, it was deemed necessary to develop a quantitative means of determining muscular stress as a parameter for seat posture optimization. Out of this need the electromyographic analysis project and the vibration project have been established. Since the inception of this VSTOL seat design program, it has become evident that similar efforts toward improving seating posture are also required in the ground vehicle environment. Thus, this project will have impact not only on future seat designs for aircraft, but also for seat designs in ground vehicles.

Progress, Status and Results:

USAARL was requested by the test facility at Edwards Air Force Base to address the problem of extreme back pain in test pilots flying the "C" model OH-58 helicopter. An evaluation of the OH-58A and OH-58C was conducted using anthropometric techniques and vibration recording instrumentation, in addition to subjective questionnaires filled out by aviators having flight time in both of those aircraft. Results of this project indicate that the back problem is not limited to the "C" model aircraft, but appears to effect pilots of both "A" and "C" models. It was observed that the anthropometry of both aircraft was the same with regard to control placement and seat configuration. It was further noted that the lumbar seat pad was not in the appropriate place to provide support to the lower back. Furthermore, placement of the controls required that the aviator of both models assume a forward slouching posture which places necessary stress on the anti-gravity muscles of the lower back. Vibration data was gathered from the OH-58A model. Similar data has yet not been obtained from the "C" model. A comparison will be made when both data are available to determine

the possibility of differences in the vibration environment of the two aircraft. The results of this study served to emphasize the current lack of concern for proper orthopedic design of aircraft seats and for proper placement of control handles for minimum muscular stress.

Papers Published:

Letter Report, Back Pain on the OH-58C Model Helicopter in progress.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0B 6889	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISS'N INSTR'N	8b. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
78 04 01	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.11.02.A	3E161102BS07	00	026
b. CONTRIBUTING				
c. ~~Contributing~~	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code)

(U) Military Acoustic Hazards: Mechanisms of Hearing Loss

12. SCIENTIFIC AND TECHNOLOGICAL AREAS: 000200 Acoustics; 012400 Personnel Selection and Maintenance (medical); 007900 Industrial (occupational) medicine

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In Thousands)
FISCAL YEAR — PRECEDING 78	2.0	193.3
FISCAL YEAR — CURRENT 79	2.9	183,061

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Lab
ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, CDR
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab
Human Tolerance & Survivability Div
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Burdick, Charles K., CPT, MSC, Ph.D.
TELEPHONE: (205) 255-4408
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Patterson, James H., Ph.D.
NAME: Mozo, Ben T.

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Acoustics, (U) Personnel Selection and Maintenance (medical); (U) Industrial (occupational) medicine; (U) Aircraft; (U) Combat vehicles

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To establish valid damage risk criteria to insure the adequate hearing protection of Army personnel exposed to continuous noise.

24. (U) Behavioral, histological, and electrophysiological procedures are used with animal models and audiometric and psychophysical procedures are used with human subjects.

25. (U) Current damage risk criteria for exposure to continuous noise are expressed in terms of A-weighted sound pressure levels. The effect of A-weighting is a de-emphasis of the importance of low-frequency noise as a hazard to hearing. The basis of the assumption that low-frequency noise is less hazardous to hearing than high-frequency noise is based solely on extrapolation from data on exposure to high-frequency noise and not on direct experimental evidence. Research has been directed toward clarifying the effects of high-intensity, low-frequency noise on hearing. Groups of chinchillas have been exposed to octave-bands of noise centered at 63 and 1000 Hz for periods of 3 days and 9 days as well as in combination. All low frequency exposures have shown their maximum effect in the high frequency region of hearing. The exposure to the combination of low and high frequency noise did not produce hearing losses significantly different from those produced by the high frequency noise band independently. The study of temporary threshold shifts in humans exposed to low frequency noise for 4 hours indicated high frequency effects also occur in the human. Three research papers were presented at scientific meetings and two papers were published in scientific journals. The project has unfunded requirements of 0.5 man-years and $13,232.

MILITARY RELEVANCY CERTIFIED UNDER SECTION 204 (FY). FUNDS)

* Available to contractors upon originator's approval

DD FORM 1 MAR 65 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORM 1498-1, 1 MAR 65, FOR ARMY USE) ARE OBSOLETE

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The Effect of Exposure to Low Frequency Noise on the Threshold of Hearing

Statement of the Problem:

Currently all damage-risk criteria for continuous noise are expressed in terms of A-weighted sound pressure levels. The effect of A-weighting is to de-emphasize the importance of low frequency sound as a possible contributor to a hearing hazard. This procedure of using A-weighted networks when measuring noise may result in potentially hazardous levels of low frequency noise being overlooked. This subtask is the first in a series of experiments to better define the potential hazard from low frequency noise.

Description of the Project:

Behavioral audiograms were obtained on eight binaural chinchillas trained on a shuttle box of voidance procedure. Four of the animals were exposed to three successive levels of an octave-band of noise centered at 63 Hz: 100 dB SPB (74 dBA), 110 dB SPL (84 dBA) and 120 dB SPL (94 dBA). The other four animals were also exposed to three successive levels of an octave-band of noise centered at 1000 Hz: 75 dB SPL (75 dBA), 84 dB SPL (85 dBA) and 95 dB SPL (95 dBA). All exposure durations were 72 hours. The inner ears of the animals were then examined using surface preparation hystology.

Progress, Status and Results:

The major results were:

(1) A permanent high frequency hearing loss to low frequency noise.

(2) Noise bands matched within 1 dBA were not equally hazardous as dictated by damage-risk criteria. The 63-Hz noise band produced nearly twice the hearing loss of the 1000-Hz band. Histological examination of the cochlea indicated that the low frequency noise did not produce the typical pattern of hair cell lesions as found with high frequency noise. The mechanism of damage from the low frequency noise is unclear.

Papers Published:

None.

Papers to Scientific Journals:

Burdick, C. K., Patterson, J.H., Mozo, B. T. and Camp, R. T., Jr. Threshold Shifts in Chinchillas Exposed to Octave-Bands of Noise Centered at 63 and 1000 Hz for Three Days. Journal of the Acoustical Society of America, 1978, 64, 458-466.

Hearing Loss and Exposure to Low Frequency Noise

Statement of the Problem:

Previous results indicated that chinchillas exposed to low frequency noise for three days incurred high frequency hearing loss. It was also found that two noise bands matched within one dBA were not equally hazardous as dictated by damage risk criteria. Questions remain concerning the characteristics of the growth pattern of the high frequency hearing loss.

Description of the Project:

Four groups of four binaural chinchillas were exposed to octave-bands of noise centered at 63 and 1000 Hz. Two groups were exposed to the low-frequency noise. One group was exposed at 110 dB SPL (84 dBA) and the other group was exposed to 120 dB SPL (94 dBA). Two groups were exposed to the high-frequency noise. One group was exposed at 85 dB SPL (85 dBA) and the other group was exposed at 95 dB (95 dBA). All exposures lasted nine days.

Progress, Status and Results:

These results confirmed the previous finding that permanent high frequency hearing losses occurred to the low frequency noise. The nine-day exposure resulted in larger permanent hearing losses produced by the high frequency noise. These results were more in line with the dictates of damage-risk criteria. Because of the equivocal nature of the hearing losses found in these two experiments, further experiments are planned. Histological evaluation of the cochleas revealed that the high-level, low-frequency noise again produced significant permanent hearing losses without significant hair cell lesions. The low-level, low-frequency exposure showed good agreement between histological findings and behavioral findings. The low-level, high-frequency exposure resulted in virtually no permanent hearing loss, however, significant hair cell lesions were produced. The high-level, high-frequency exposure produced scattered hair cell lesions which did not correspond particularly well with the permanent hearing losses incurred by those animals. There was also evidence of damage to the stria vascularis in both high-level exposure conditions.

Papers Published:

None.

Papers to Scientific Journals:

Burdick, C. K., Patterson, J. H., Mozo, B. T., Hargett, C. E., Jr., and Camp, R. T., Jr. Threshold Shifts in Chinchillas Exposed to Low Frequency Noise for Nine Days. Journal of the Acoustical Society of America, 1977, 62S, S95. (Abstract).

The Effect on Hearing of Exposure to Combination of Low Frequency and High Frequency Noise

Statement of the Problem:

This study was concerned with the possible synergistic or interactive effects of exposure to low and high frequency noise. This was particularly of interest since both bands of noise have been found to independently affect the same frequency region of hearing.

Description of the Project:

Chinchillas were exposed to octave-bands of noise centered at 63 Hz and at 1000 Hz. The intensity levels were 120 dB SPL for the 63 Hz octave-band noise and 94 dB SPL for the 1.0 kHz octave-band noise. Consequently, both noise bands were at a level of 94 dBA. One group of animals was exposed to the low frequency noise for 4 1/2 days followed by exposure to the high frequency noise for 4 1/2 days, a second group received the reverse exposure, and the third group was exposed for nine days to both bands of noise simultaneously.

Progress, Status and Results:

All three exposure conditions resulted in similar threshold shifts. The peak shift of about 65 dB for the simultaneous exposure condition is almost exactly that which would be predicted for a 3 dB increase in exposure energy over the threshold shifts found for the 95 dB 1.0 kHz exposure. The amounts of permanent hearing loss incurred from the three exposures was very similar with maximum losses of about 20 dB at 1.4 and 2.0 kHz. This is similar to the previous results within independent exposures. The results of the combination exposures failed to find any evidence, behaviorally, of an interactive affect of exposure to low and high frequency noise. Histological evaluation of the cochlea is currently underway.

Papers Published:

None.

Papers to Scientific Journals:

None.

Temporary Threshold Shift in Man Resulting From Four Hour Exposures to Octave-Bands of Noise Centered at 63 and 1000 Hz

Statement of the Problem:

The effects of low frequency noise on hearing have been investigated using animal subjects. In order to apply these findings to potential hazard to humans, it is necessary to obtain comparative data. Since humans cannot be given exposures which would result in permanent hearing loss, the necessary comparison between human and animal subjects is accomplished by examination of the early growth of temporary threshold shift.

Description of the Project:

Human subjects were exposed for four hours to octave-bands of noise centered at 63 and 1000 Hz. Exposure levels for the low frequency noise were 110 dB SPL (84 dBA) and 120 dB SPL (94 dBA). Exposure levels for the high frequency noise were 85 dB SPL (85 dBA) and 95 dB SPL (95 dBA).

Progress, Status and Results:

The results indicate that in man, as in chinchillas, sizable temporary threshold shifts are induced at high frequencies by exposure to the 63 Hz octave-band of noise. These results indicate that the human ear responds in a fashion similar to that of the chinchilla to the low frequency bands of noise.

Papers Published:

None.

Papers to Scientific Journals:

Patterson, J. H., Burdick, C. K., Mozo, B. T., and Camp, R. T., Jr. Temporary Threshold Shifts in Man Resulting From Four Hour Exposures to Octave-Bands of Noise Centered at 63 and 1000 Hz. Journal of the Acoustical Society of America, 1977, 62S, S95 (Abstract).

Burdick, C. K., Patterson, J. H., Mozo, B. T., and Camp, R. T., Jr. High-Frequency Hearing Loss Incurred by Exposure to Low-Frequency Noise. Proceedings of the 1978 Army Science Conference, 1978, Vol I, 187-199.

Investigation of the Relationship Between Eye Pigmentation and Susceptability to Noise Induced Hearing Loss

Statement of the Problem:

For years it has been known that people display differential sensitivity to noise. This is reflected by differences in the amounts of hearing loss sustained by individuals having similar sound exposure histories. As yet, we are unable to preduct those individuals who are likely to suffer the most damage to a given noise exposure. The identification of a factor which would provide some predictive capability, which could be used to identify high risk individuals would greatly enhance our protective capability. Research indicates that melanin may play a protective role in the ear as well as to the skin. This investigation concerns the ability to identify high risk individuals on the basis of eye pigmentation.

Description of the Project:

Groups of pigmented and albino guinea pigs will be exposed to the same bands of noise and the resultant amounts of both temporary and permanent hearing loss will be compared.

Progress, Status and Results:

Initial training of the subjects has begun.

Papers Published:

None.

Papers to Scientific Journals:

None.

Sound-Quality Learning by the Chinchilla in a Two-Choice Psychophysical Procedure

Statement of the Problem:

To determine the feasibility of developing a two-choice psychophysical procedure for the evaluation of the effects on threshold measurement of changing shock-density and of using asymmetric payoffs to determine auditory thresholds in chinchillas exposed to low-frequency noise.

Description of the Project:

Chinchillas will be trained on a two-choice task with a situation designed so that cues of sound-quality and sound-locus will be available for the learning phase of the study. The subjects will then be tested to determine which cue, sound-quality, or sound-locus was used to learn the task.

Progress, Status and Results:

Equipment fabrication has been completed.

Papers Published:

None.

Papers to Scientific Journals:

None.

Comparison of Audiometric Procedures With the Chinchilla

Statement of the Problem:

An assessment will be made as to the suitability of using a modified shock avoidance procedure for obtaining thresholds of the chinchilla and for the utilization of this process to develop a fully automated audiometric test facility under microprocessor control for experiments with low-frequency noise exposure.

Description of the Project:

Auditory thresholds will be obtained on a group of chinchillas using the standard, shock-avoidance procedure currently being used. Subsequently, auditory thresholds will be determined using a licking based response procedure. A comparison of the threshold measurements obtained using both procedures will then be made. An evaluation as to the suitability for the development of a totally automated procedure using this alternative behavioral method for threshold measurement will be accomplished.

Progress, Status and Results:

Initial training on subjects has begun.

Papers Published:

None.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0B 6885	78 11 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DIS'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	H. TERMINATE	U	U			☒ YES ☐ NO	A. WORK UNIT

10. NO. CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.11.02.A	3E161102BS07	00	022
b. CONTRIBUTING				
c. [illegible]	CARDS 114	(f) (m)		

11. TITLE (Precede with Security Classification Code)*

(U) Military Applications of Auditory Assessment

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 000200 Acoustics; 012400 Personnel selection and maintenance (medical); 001300 Aircraft

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT: Not Applicable

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:*

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	0	.393
	CURRENT 79	0	0

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory

ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, Cdr

TELEPHONE: (205) 255-2813

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Lab
Human Tol & Suvivability Division

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* Patterson, James H., Ph.D.

TELEPHONE: (205) 255-4408

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Burdick, Charles K., CPT, MSC, Ph.D.

NAME:

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Acoustics; (U) Personnel selection and maintenance (medical); (U) Aircraft; (U) Industrial (occupational) medicine; (U) Communications

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) Investigation of techniques, materials, procedures, and instrumentation for assessing auditory perception, susceptibility to acoustic insult, job performance prediction based on audiometric test results, relationship of auditory deficits and work noise environment affecting job performance and quantification of typical hearing loss in special acoustic environments.

24. (U) Basic principles of psychoacoustics, psychophysics, audiology, and standard methods for measurement of speech intelligibility and discrimination will be used.

25. (U) Due to a critical personnel shortage no research has been accomplished on this work unit since the previous summary. Therefore, it is being suspended until adequate resources are available.

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 68 AND 1498.1 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.

* U.S. GPO: 1974—546-047/6691

Military Applications of Auditory Assessment

Statement of the Problem:

Investigation of techniques, materials, procedures and instrumentation for assessing auditory perception, susceptibility to acoustic insult, job performance prediction based on audiometric test results, relationship of auditory deficits and work noise environment affecting job performance and quantification of typical hearing loss in special acoustic environments.

Progress, Status and Results:

Due to a critical personnel shortage no research has been accomplished on this work since the previous summary. Therefore, it is being suspended until adequate resources are available.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0B 6886	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISB'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	U	U	NA	NL	[X] YES [ ] NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162773A819	00	050
b. CONTRIBUTING	6.11.02.A	3E161102BS07	00	023
c. [illegible]	CARDS 114 (f)	(m)		

11. TITLE (Precede with Security Classification Code)

(U) Medical Assessment of Hearing Protective Devices

12. SCIENTIFIC AND TECHNOLOGICAL AREAS: 000200 Acoustics; 013300 Protective Equipment; 007900 Industrial (occupational) medicine

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	1.375	63.123
FISCAL YEAR CURRENT 79	2.85	135,834

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Lab
ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, CDR
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab
Human Tolerance & Survivability Div
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Mozo, Ben T.
TELEPHONE: (205) 255-4408
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Camp, Robert T., Jr.
NAME:

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Acoustics; (U) Protective Equipment; (U) Industrial (occupational) medicine; (U) Aircraft; (U) Radio communication; (U) weapons effects

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) This research assesses the sound-attenuating characteristics of hearing protective devices as to their suitability to meet the needs of the Army and develops new hearing protective devices and methods for evaluating them.

24. (U) Methods utilized for the determination of the sound attenuation characteristics of hearing protective devices will be ANSI Z22.24-1957 and ASA S3.19, 1974. Objective electroacoustic methods will also be used.

25. (U) A variety of hearing protective devices were evaluated for their sound attenuation characteristics. Included were devices from the qualified products list the DH-178 helmet for possible use with the M-198 howitzer. A report on the DH-178 reflects the research in this subtask, Medical Evaluation of Sound Attenuation and Electroacoustics Characteristics of a Prototype DH-178 Protective Helmet. USAARL Report No. 78-12, June 1978. This project has unfunded requirements of 0.35 man-years and $11,890.

MILITARY RELEVANCY CERTIFIED UNDER SECTION 204 (FY ___ FUNDS)
BY [signature]

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

Real-Ear Sound Attenuation Studies

Statement of the Problem:

DA Circular 40-18 dated 3 August 1976 "Command Emphasis on Hearing Conservation Programs" establishes a requirement for an effective hearing conservation program in the Army. This project is in direct support of the Army hearing conservation program. The information generated in this subtask is used in the selection of hearing protective devices for use by the Army. It is part of the in-house research program.

Military relevance - One of the cornerstones of the Army hearing conservation program is the use of personal hearing protective devices in hazardous noise environments. The success of this program depends on the availability of adequate hearing protective devices and knowledge of the attenuation characteristics of the devices.

Description of the Project:

The purpose of this project is to provide improved hearing conservation for the Army by collecting real-ear attenuation data on a variety of hearing protectors as required for the selection of the most suitable devices for use by US Army personnel.

Progress, Status and Results:

The following devices have been tested in FY 78:

1. DH-178 helmets for M-198 weapons.
2. Gentex SPH-4 helmet for use with XM-29 gas mask.
3. Gentex SPH-4 helmet with E-A-R hearing earplugs.
4. Gentex DH-178 helmet in active and passive mode.
5. Gentex SPH-4 lightweight helmet with pads.
6. Gentex SPH-4 helmet with special Kevalar Sonex earcups installed in a new retention design.
7. Gentex SPH-4 helmet with 75-C-2990 seals.
8. Gentex modified SPH-4 helmet.
9. David Clark Model E-310 straight away in behind the head and under the chin configurations.
10. Glendale Optical Quiet Line GN900 in behind the head and under the chin configurations.
11. Glendale Optical Quiet Line GN951 earmuff.
12. Glendale Optical Quiet Line GN901 earmuff.
13. David Clark E-105 earmuff.
14. Flents 080 model U Silenta Universal earmuff in over the head, under the chin and behind the head configurations.
15. Willson sound barrier 253 earmuff with fluid cushions.

16. American Optical 1200 Hear Guard.
17. American Optical 1720 Hear Guard in under the chin and behind the head configurations.
18. American Optical 1700 earmuff in over the head, behind the head and under the chin configurations.
19. David Clark Model 117 earmuff.
20. Mine Safety Appliance Noise Foe Mark IV in over the head, behind the head and under the chin configurations.
21. Bilsom International NFM-1.
22. Willson Sound Silencer EP100G earplugs.
23. Willson Sound Silencer EP101B earplugs.
24. Willson Sound Ban Hearing Protector in over the head, under the chin and behind the head headband configurations.
25. Marion Health and Safety Deci Damp earplugs.

Papers Published:

"Medical Evaluation of Sound Attenuation and Electroacoustics Characteristics of a Prototype DH-178 Protective Helmet." USAARL Report No. 78-12, June 1978.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA 0B 6887	78 11 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISS'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	H. TERMINATE	U	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.11.02.1	3E161102BS07	00	024
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code)*

(U) Medically Significant Problems of Voice Communication Systems

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 021000 Radio communications; 000100 Acoustic detection; 007900 Industrial (occupational) medicine

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT: Not Applicable
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:*
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	0	.518
	CURRENT		

19. RESPONSIBLE DOD ORGANIZATION
NAME:* US Army Aeromedical Research Laboratory
ADDRESS:* Fort Rucker, AL

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr
TELEPHONE: (205) 255-2813

20. PERFORMING ORGANIZATION
NAME:* US Army Aeromedical Research Lab
Human Tolerance & Survivability Div
ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME:* Camp, Robert T., Jr.
TELEPHONE: (205) 255-4408
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Mozo, Ben T.
NAME: Marrow, Ronny

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)
(U) Radio communications; (U) Acoustic detection; (U) Industrial (occupational) Medicine; (U) Aircraft; (U) Acoustics; (U)Combat Vehicle

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) The acoustic environments associated with military training and operations in Army helicopters and tanks are usually hazardous and may cause interference with effective voice communications and the detection of warning signals. Most of the present aviation communication systems have characteristics that introduce both frequency and amplitude distortion of the speech signals.

24. (U) This research will be directed toward the development of an improved noise cancelling microphone for use in Army aircraft. Improved radio communication systems will be developed for Army aircraft and armor vehicles (e.g., MICV). New communication devices such as contact microphones will be evaluated for their potential use in Army systems.

25. (U) Due to a critical personnel shortage minimal research has been accomplished on this work unit since the previous summary. Progress is represented by USAARL LR-78-19-2-3 and "Radio Set AN/PRC( ) Improved Audio," Cincinnati Electronics Corp., Final Report, No. DABT01-77-C-0274, 20 April 1978. This research is being suspended until adequate resources are available.

*Available to contractors upon originator's approval.

DD FORM 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65

Medically Significant Problems of Voice Communication Systems

Statement of the Problem:

The acoustic environments associated with military training and operations in Army helicopters and tanks are usually hazardous and may cause interference with effective voice communications and detection of warning signals. Most of the present military communication systems have characterististics that introduce both frequency and amplitude distortion of the speech systems. Also many systems contain high distortion of the speech systems. Additionally many systems contain high intensity system noise which may be a source of hazardous acoustic energy.

Description of the Project:

The present research project is concerned with the investigation of various communication systems that may be a source of hazardous sound pressure levels and may cause speech interference. The objectives of the project is to investigate new generation noise cancelling microphones and modified transceivers with electrical characteristics that yield high quality communication systems with low system noise.

Progress, Status and Results:

New generation noise cancelling microphones have been developed and in FY 78, two AN/PRC-70 transceivers were modified and subjected to limited tests. The results indicated that the performance of the modified transceivers, with the new generation noise cancelling microphone, yield high quality communications without hazardous system noise. It is recommended that research in this area be continued to achieve more thorough and a greater variety of tests for all types of Army communication applications. We have also investigated the problems of excessively low rpm warning signals on interference of speech communications that allegedly caused helicopter accidents.

Papers Published:

USAARL Letter Report No. 78-19-2-3.

"Radio Set AN/PRC Improved Audio," Cincinnati Electronics Corp., Final Report, No. DABT01-77-C-0274, 20 April 1978.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA 0B 6888	78 11 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	H. TERMINATE	U	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO. CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.11.02.A	3E161102BS07	00	025
b. CONTRIBUTING				
c. (illegible)	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code)*

(U) Acoustic Environment of Army Prototype Equipment

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

000200 Acoustics; 001300 Aircraft; 003700 Combat Vehicles

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT: Not applicable

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:*

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR — PRECEDING: 78	.875	45.069
FISCAL YEAR — CURRENT:		

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory

ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, Cdr

TELEPHONE: (205) 255-2813

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Lab
Human Tolerance and Survivability Div

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* Mozo, Ben T.

TELEPHONE: (205) 255-4408

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Camp, Robert T., Jr.

NAME: Patterson, James H., Ph.D.

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Acoustics; (U) Aircraft; (U) Combat vehicles; (U) Protective Equipment; (U) Weapons Effects; (U) Industrial (occupational) medicine

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) The principle technical objective of this project is to quantify the acoustic environments associated with new Army materiel in order to assess the hearing damage potential and to support the materiel developers to produce less hazardous equipment.

24. (U) Methods for measurement and analysis of high-intensity impulse noise are under development to quantify the noise characteristics of new weapons systems and other sources of impulse noise. Standard Methods of measurement and physical acoustics will be employed.

25. (U) At the request of ARMTE White Sands Missile Range, New Mexico, sound pressure levels produced by an improved rocket motor on the Chapparal missile system were measured. These measurements were made to assess the acoustical hazard to the crew during firing. Measurements are complete. The analysis and report are in progress. The project has been delayed due to lack of personnel resources and higher priority projects. At the request of the Department of Evaluation and Standardization, measurements were compiled on the C-12 aircraft internal noise conditions. It was determined that some flight conditions exceed the 85 dBA limit and recommended hearing protective methods be instituted. At the request of the US Army Aviation Board sound pressure levels produced by an ALQ-144 infrared suppressor were evaluated. Sound pressure levels indicated hearing protective methods for maintenance personnel were required. Progress is represented by USAARL-LR-13-2-2 "Internal Noise Characteristics of a U.S. Army C-12A Aircraft", USAARL-LR-78-20-2-4 "Sound Pressure Levels Produced by an ALQ Infrared Suppressor.", and USAARL-LR-78-2-2-1 "Noise Levels Measured in the First Run Production Models of the AH-1S Cobra Helicopter." This research is being terminated due to a critical personnel shortage.

*Available to contractors upon originator's approval.

DD FORM 1 MAR 66 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 66 (FOR ARMY USE) ARE OBSOLETE

Acoustic Environment of Prototype Equipment

Statement of the Problem:

New Army aviation systems, like other Army equipment, present new noise problems during their development. It is essential that these systems be evaluated as to the health hazard associated with their operation. This research project is involved with assessing the acoustic hazard of prototype equipment to Army personnel.

Description of the Project:

This research is to provide the basis for hazard assessment of new Army systems by determining the noise spectra of the various acoustic environments which will be imposed on Army personnel.

Progress, Status and Results:

At the request of ARMTE White Sands Missile Range, New Mexico, sound pressure levels produced by an improved rocket motor on the Chaparral missile system were measured. These measurements were made to assess the acoustical hazard to the crew during firing. Measurements are complete. The analysis and report are in progress. The project has been delayed due to lack of personnel resources and higher priority projects.

At the request of the Department of Evaluation and Standardization, measurements were compiled on the C-12 aircraft internal noise conditions. It was determined that some flight conditions exceed the 85 dBA limit and recommended hearing protective methods be instituted.

At the request of the US Army Aviation Board sound pressure levels produced by an ALQ-144 infrared suppressor were evaluated. Sound pressure levels indicated hearing protective methods for maintenance personnel were required.

Papers Published:

USAARL Letter Report No. 78-13-2-2, "Internal Noise Characteristics of a U. S. Army C-12A Aircraft"

USAARL Letter Report No. 78-20-2-4, "Sound Pressure Levels Produced by an ALQ Infrared Suppressor"

USAARL Letter Report No. 78-2-2-1, "Noise Levels Measured in the First Run Production Models of the AH-1S Cobra Helicopter."

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA OC 6471	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. CHANGE	U	U			☐ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162173A819	00	041
b. CONTRIBUTING	6.27.73.A	3E62773A818		
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)*

(U) Medical Effects of Blast Overpressure

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 000200 Acoustics; 013300 Protective Equipment; 007900 Industrial (occupational) Medicine

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
77 10	1982	DA	C. In-House

17. CONTRACT/GRANT Not Applicable

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:*

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	5.5	425
	CURRENT 79	2.5	355

19. RESPONSIBLE DOD ORGANIZATION

NAME:* Walter Reed Army Institute of Research

ADDRESS:* Washington, DC 20012

RESPONSIBLE INDIVIDUAL

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TELEPHONE: (202) 576-3236

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Lab
Human Tolerance & Survivability Div

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* Patterson, James H., Ph.D.

TELEPHONE: (205) 255-4408

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Mozo, Ben T.

NAME: Burdick, Charles K., CPT, MSC, Ph.D.

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Acoustics; (U) Protective Equipment; (U) Industrial (occupational) Medicine; (U) Weapons Effects; (U) Impulse Noise

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To define the physiologic effects upon the auditory system of blast overpressure generated by firing Army weapons systems in terms of the physical characteristics of the pressure wave responsible for injury to the auditory system and potential protective devices and mechanisms.

24. (U) The approach is three pronged: 1. Physical measurements to define the nature of the noise and on which to base hazard assessment. 2. Direct validation of hearing protective devices and development of indirect methods to determine their adequacy. 3. Basic animal and human studies to develop a data base for more accurate tolerance limits (Damage Risk Criteria) for impulse noise.

25. (U) During the fiscal year measurements of the M110, 8 in self propelled howitzer were completed. Initial validation of a shock tube simulation for the M198, 155mm towed howitzer was accomplished in consort with the Inhalation Toxicology Research Institute at Albequerque, NM. A protocol for the determination of the adequacy of hearing protection for use in high intensity impulse noise was approved and a contract with the University of New Mexico was negotiated to implement this protocol. Fabrication and preliminary evaluation of a six station audiometer to be used in the implementation of the protocol were completed. Attenuation characteristic often DH-178 helmets was completed. Data analysis was completed and the first draft of the report on the blast overpressures produced by the M198 was written.

*Available to contractors upon originator's approval.

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.

Blast Overpressure

Statement of the Problem:

Within the last year the problem of the hazard to hearing from impulse noise has reached crisis proportions. The latest Army interest in this problem arose out of concern for the safety of artillery crews firing the XM198/XM203 155 MM Howitzer. Attention has focused on two primary issues: (1) What constitutes hazardous impulse noise? (2) What constitutes adequate hearing protection? These are the fundamental issues in the auditory part of the blast overpressure problem

Description of the Project:

Resolution of the auditory portion of the blast overpressure problem involves four parts: (1) Complete quantification of the transient pressure disturbance associated with the blast, (2) Quantification of the attenuation characteristic of hearing protective devices, (3) A method for combining the transient pressure disturbance with the attenuation characteristics of hearing protective devices to yield an estimate of the effective auditory exposure, and (4) A valid auditory damage risk criterion for assessing the hazard to hearing from impulse noise.

Progress, Status and Results:

During this fiscal year measurements of the M110, eight inch self-propelled howitzer were completed. This was a joint measurement with Materiel Test Directorate, Aberdeen Proving Ground, to begin resolving measurement technology differences between USAARL and MTD. Analysis of data obtained by both agencies is still in progress. Initial validation of a shock tube simulation for the M198, 155mm towed howitzer was accomplished in consort with the Inhalation Toxicology Research Institute at Albequerque, NM. A protocol for the determination of the adequacy of hearing protection for use in high intensity impulse noise was approved and a contract with the University of New Mexico was negotiated to implement this protocol. Fabrication and preliminary evaluation of a six-station audiometer to be used in the implementation of this protocol was completed. Attenuation characteristic of ten DH178 helmets was completed in preparation for this study. Data analysis was completed and the first draft of the final report on the blast overpressures produced by the M198 was written.

Papers Published:

Patterson, James H., Nelson, W. R., Marrow, R.H., Hargett, C. E., Jr., and Camp, R. T., Jr., "Medical Evaluation of Sound Attenuation and Electroacoustics Characteristics of a Prototype DH-178 Protective Helmet," USAARL Report No. 78-12, June 1978.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DAOC 6888	78 10 01	DD-DRS(AR)636

3. DATE PREV SUMRY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8. DISPOSITION	9. SPECIFIC DATA CONTRACTOR ACCESS	9. LEVEL OF SUM
78 08 28	D. Change	U	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.75.A	3E762775A819	00	019
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code): (U) Multi-Axis Vibration Simulator (MAVS) Validation for Reproduction of Armored (Tracked) Vehicle Vibrations in Human Tolerance Studies

12. SCIENTIFIC AND TECHNOLOGICAL AREAS: 002400 Bioengineer; 016200 Stress Physiology; 005700 Test Facilities; 003700 Combat Vehicles; 019800 Simulation and Systems

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
78 06	79 09	DA	C. In-House

17. CONTRACT GRANT
a. DATES/EFFECTIVE: NA EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	.4	40.
FISCAL YEAR CURRENT 79	3.0	235

19. RESPONSIBLE DOD ORGANIZATION
NAME: US Army Aeromedical Research Lab
ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: KNAPP, Stanley C., COL, Cdr
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION
NAME: US Army Aeromedical Research Lab
Fld Rsch & Biomed Appl Division
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: JOHNSON, John C., CPT, MSC
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SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: LEWIS, J. A., GS-11
NAME: JENKINS, J. M., GS-9

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code): (U) Vibration; (U) Simulation; (U) Accelerations; (U) Human Tolerance; (U) Tracked Vehicle

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) This study will develop the techniques and methodology necessary for accurate reproduction or simulation of armored (tracked) vehicle vibrations on the USAARL Multi-Axis Vibration Simulator (MAVS). This task is a mandatory prelude to the evaluation of physiological and performance effects of vehicular vibration on armored vehicle crewmembers. Specific objectives include: a. determination of the vibration exposure presented to crewmen of currently fielded tracked vehicles; b. determination of the optimum method of reproducing these vibrations on the MAVS for: (1) direct reproduction, (2) random noise simulation, and (3) periodic simulation; c. determination of the vibration transfer characteristics for common crew seat configurations in currently fielded tracked vehicles; and d. development of a method of vehicular vibration and analysis for the evaluation of medical aspects of vibration.

24. (U) The approach to the problem will be fourfold: a. obtain characteristic vibration signatures from tracked vehicles during typical missions; b. optimize the control system on the MAVS to accurately simulate tracked vehicle vibrations; c. perform model analysis and vibration transfer function analysis on typical seat types; and d. measure vibration transmitted to the human subjects during simulated vibration on the MAVS.

25. (U) 77 10 - 78 09. Instrumentation to measure the transmissibility of various crew seats and postures has been ordered or assembled. This instrumentation includes a mouth-mounted triaxial accelerometer for the determination of head vibrations experienced by human subjects while using each seating configuration. Metallurgical problems encountered by the contractor who is refurbishing the MAVS may delay the completion of this project. The MAVS is restricted to single axis operation until the problem is resolved.

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Multi-Axis Vibration Simulator (MAVS) Validation for Reproduction of Armored (Tracked) Vehicle Vibrations in Human Tolerance Studies

Statement of the Problem:

The vibration levels produced by tracked (armored) vehicles are similar to those produced by heavy construction equipment in the civilian community. The latter class of vehicles has been shown to produce a wide variety of pathological changes in human operators who are exposed to vehicle vibrations over a prolonged period of time. However, no standards exist within the Army which limit the vibration exposure of tracked vehicle operators nor have human tolerance standards been developed for use as guidelines in the design of tracked or armored vehicles.

Description of the Project:

This study will develop the techniques and methodology necessary for accurate reproduction or simulation of armored (tracked) vehicle vibrations on the USAARL Multi-Axis Vibration Simulator (MAVS). This task is a mandatory prelude to the evaluation of physiolcgical and performance effects of vehicular vibration on armored vehicle crewmembers. Specific objectives include: (1) determination of the vibration exposure presented to crewmen of currently fielded tracked vehicles; (2) determination of the optimum method of reproducing these vibrations on the MAVS for (a) direct reproduction, (b) random noise simulation, and (c) periodic simulation; (3) determination of the vibration transfer characteristics for common crew seat configurations in currently fielded tracked vehicles; and (4) development of a method of vehicular vibration and analysis for the evaluation of medical aspects of vibration. The approach to the problem will be fourfold: (1) Obtain characteristic vibration signatures from tracked vehicles during typical missions; (2) optimize the control system on the MAVS to accurately simulate tracked vehicle vibrations; (3) perform model analysis and vibration transfer function analysis on typical seat types; and (4) measure vibration transmitted to the human subjects during simulated vibration on the MAVS.

Progress, Status and Results:

Instrumentation to measure the transmissibility of various crew seats and postures has been ordered or assembled. This instrumentation includes a mouth-mounted triaxial accelerometer for the determination of head vibrations experienced by human subjects while using each seating configuration. Coordination with other government agencies in obtaining vehicle vibration spectra and/or raw vibration data has begun. Engineering drawings for a semi-reclining seat similar to that used in the XM-1 tank and the HSTV(L) should be received in the near future. A prototype of this seat will be fabricated in-house

and used as one of the test items. A two-channel, fast Fourier Transform Analyzer originally ordered to do analysis of electromyographic data will be used in this study to calculate transfer functions in real time. Metallurgical problems encountered by the contractor who is refurnishing the MAVS may delay the completion of this project. The MAVS is restricted to single axis operation until the problem is resolved.

Papers Published:

None.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0B 6891	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISB'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	U	U	NA	NL	☐ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.11.02.A	3E161102BS07	00	028
b. CONTRIBUTING	6.27.73.A	3E162773A819	00	002
c. CONTRIBUTING	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code)

(U) Research of Visual Problems Medically Significant to the Army

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 012000 Optics; 012900 Physiology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	4.0	194
FISCAL YEAR CURRENT 79	2.1	87

19. RESPONSIBLE DOD ORGANIZATION

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SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Glick, D.D., MAJ

NAME: Behar, I.

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Vision; (U) Man-Machine Interface; (U) Visual Psychophysics; (U) Night Vision; (U) Visual Correction; (U) Visual Protection

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information about the visual sensory modality relating to capability of the human visual system and the impact of military equipment, environmental and operational influences on visual performance and integrity.

24. (U) The approach will include psychophysical, electrophysiological, and other objective techniques to evaluate human visual performance with quantitative measures.

25. (U) Progress is shown through basic work in velocity misjudgement in aviation from studies in Dynamic Visual Acuity; through Human Use Review Committee's approval of the Extended Wear Contact Lens Study; through completion of data collection in the Aviation Ophthalmic Frame Field Study; and through fund data analysis of the Cross-Sectional Survey of Selected Visual Parameters. This project has unfunded requirements of 0.45 man-years and $12,119.

MILITARY RELEVANCY CERTIFIED UNDER SECTION 204 (FY - FUNDS)
BY R. O. Lynch

* Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

Studies of Dynamic Visual Acuity

Statement of the Problem:

This project utilizes the dynamic visual acuity (DVA) paradigm to evaluate a variety of visual parameters. Previous applications in this laboratory have been in the areas of pilot fatigue and ocular dominance. It has also been valuable in assessing visual degradation produced by protective masks. During the conduct of these studies, a number of our subjects reported that the smaller acuity targets appeared to be moving faster than the larger targets even though the objective velocities were the same. This study was undertaken to determine whether the size of the target influences its perceived velocity.

Description of the Project:

A number of previous studies have already demonstrated that perceived velocity is influenced by the sizes of the moving objects. However, it has been considered essential that at least one of the following conditions be met: (a) That there be a visible frame surrounding the motion field or some stationary objects nearby: (b) That there be a recurrence of moving objects in uniform succession; (c) That the eyes maintain fixation on a stationary object. In our study, none of these conditions were met. Our subjects pursued individual moving targets (Landolt Cs) presented against a uniform background of darkness. In the primary experiment, the targets ranged in overall angular size from 1° to 7'. In a control study, the overall size of the Landolt Cs remained the same but the sizes of the critical detail, i.e., the gap width, varied over a 5 to 1 range.

Progress, Status and Results:

In the main experiment, overall target size was a highly significant determiner of perceived velocity. In the control experiment, resolution tasks demands were found to have no effect. The main experiment ruled out explorations based on field effects, interactions between stationary and moving contours, or mediation by a frequency or counting mechanism. The favored exploration is that this is an instance of misapplied constancy. Because of the serious implications of this misjudgment of velocity in aviation, this aspect of the project will be continued.

Extended Wear Contact Lenses

Statement of the Problem:

The Army is using, or intends to use, several optical devices which are not compatible with spectacles. Contact lenses would permit uninterrupted use of these devices by the soldier in the field. In the past, hard or soft contact lenses had to be removed, following 12 to 16 hours wear, in order to insure corneal integrity. They also had to be chemically cleaned or heat treated daily to insure sterility. This was not feasible for the field soldier. There are now soft lenses available for continuous wear. This study will examine these lenses for use in the military environment.

Description of the Project:

The subjects will be selected from the Army aviation environment assigned to Fort Rucker. There will be seven groups of approximately six subjects each. The first group will wear the lenses for 24 hours, the second 48 hours, etc., with the final group wearing the lenses the full seven-day period. The subjects will be thoroughly examined prior to and following their wearing period. The examination parameters include biomicroscopy, pachometry, keratometry, photoelectric keratoscopy and visual acuity.

Progress, Status and Results:

The Human Use Review was approved in the 4th Quarter, FY 78. Data collection is anticipated in the 2d Quarter, FY 79.

Field Study Aviator Opthalmic Frame

Statement of the Problem:

The standard issue metal aviator's frame (FG-58) has received good acceptance from user personnel and has provided reasonable serviceability. Therefore, some design and safety deficiencies have been accepted in the past. However, recent increases in the cost of these frames and changes in the material from which they are made have forced a search for an acceptable substitute. This study is a joint Air Force/Army program in which a new frame made from thermosetting plastic is being field tested.

Description of the Project:

The Army portion of the program requires that the test frames be issued to and worn by 300 active duty Army aviators on flight status. The volunteers are from: Fort Ruker (150); Fort Campbell (50); Fort Richardson (50); and Fort Hood (50). The personnel will wear the frame for one year and will be questioned quarterly to obtain test data for frame serviceability and compatibility. The Air Force research personnel are conducting their portion of the program at selected Air Force bases.

Progress, Status and Results:

Data collection is complete and published results are anticipated in 2d Quarter, FY 79.

Papers Published:

None.

Papers to Scientific Journals:

None.

Cross-Sectional Survey of Selected Visual Parameters

Statement of the Problem:

Descriptive statistics concerning visual parameters of the military community were not available to equipment developers. For example, dioptric and interpupillary adjustments need to accomodate the majority of users.

Description of the Project:

Data sheets were provided to several Army optometry clinics throughout CONUS. More than 9,000 completed forms were returned for analysis. The sample included only those persons who actively sought a vision examination; however, this is the group in which the optical equipment developer is most interested.

Progress, Status and Results:

Sixty-four percent of the sample had myopic spherical refractive errors and twenty-seven percent were hypermetropic. There was a significant difference in the refractive errors of the males and females, with the latter exhibiting more myopia. Eighty-four percent of the sample had astigmatic refractive errors of 1.00 diopters or less. The sample demonstrated that dioptric adjustments would compensate 97% of the myopes if the range was shifted toward myopic correction. Fourteen percent of the males and seven percent of the females required near-point corrections (in addition to a distant vision correction). The 5th to 95th percentile range for male interpupillary distance was 59mm to 72mm. For females, the range was 52mm to 72mm.

Papers Published:

The laboratory report will be published in FY 79.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA0B 6893	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73A	3E162773A819	00	004
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code):
(U) Visual and Optical Evaluation of Non-Medical Material

12. SCIENTIFIC AND TECHNOLOGICAL AREAS:
001300 Aircraft; 012000 Optics; 012900 Physiology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	3.24	119
FISCAL YEAR CURRENT 79	2.1	54,000

19. RESPONSIBLE DOD ORGANIZATION
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20. PERFORMING ORGANIZATION
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PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
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SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Glick, D.D. MAJ
NAME: Holly, F. F., CPT

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)
(U) Aircraft; (U) Cockpit Lighting, (U) Optical Aberrations; (U) Vision; (U) Photometry; (U) Colorimetry; (U) Optical Transparencies

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information on those aspects of the ambient or instrument environment which might adversely affect or enhance the human visual system and military operational activity dependent upon visual performance.

24. (U) The approach will include physical optics techniques, photometry, spectrometry, and colorimetry to measure the fidelity, magnitude, and temporal characteristics of the visual environment and, using psychophysical procedures, determine the effects of the visual stimuli on visual performance.

25. (U) Progress is shown in: USAARL-LR-78-6-7-4, Nov. 1977, Night Vision Goggle Training in the 2B31 Synthetic Flight Trainer Simulator; USAARL-LR-78-17-7-7, Jun 78, Contrast Enhancing Eye Shields for Daytime Training with Night Vision Goggles, AN/PVS-5; and USAARL-LR-78-18-7-8, June 1978, Goniophometric Evaluation of Landing Light Diffusers for Night Vision Goggle Training. This project has unfunded requirements of 1.45 man-years and $31,180.

MILITARY RELEVANCY CERTIFIED UNDER
SECTION 204 (FY ..... FUNDS)
BY .....

* Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 65 AND 1498 1 MAR 65 (FOR ARMY USE) ARE OBSOLETE

Night Vision Goggle, AN/PVS-5, Modification for Daytime Training

Statement of the Problem:

The aims of this project are to develop systems for night vision goggle training which may reduce the associated cost and logistical problems, as well as provide an added margin of safety. The primary approach has been the development of daytime filters which allow the NVGs to be used as their own simulator by providing reasonable approximation of night imagery during full daylight and without compromising the life of the intensifier tubes.

Description of the Project:

The night vision goggles, AN/PVS-5, permit the extension of helicopter operation under night illumination levels well below those of useful naked eye visibility. While the goggles provide enhancement of sensitivity at low light levels, they do not, however, preserve the performance capability of other visual parameters; for example, the visual field of view is reduced to 40°, visual acuity is degraded to about 20/60, hue discrimination is absent, and contrast sensitivity and stereoscopic vision are markedly impaired. Adjustment of focus for distant and instrument viewing requires manual adjustment and is, therefore, time consuming.

In view of the drastic alteration and degradation of visual information effected by the NVGs, flying with goggles require a period of training. Our current experience indicates that some five hours of training is appropriate for the average aviator. However, NVG training at night involves some risk since the IP also must wear the goggles, is costly, requiring a chase ship and reduced stagefield density and dependent upon the phase of the moon as well as weather conditions.

Progress, Status and Results:

An analysis of problem areas encountered with daytime filters for the NVGs using standard neutral density filters identified the following: flare, resolution reduction, false contrast with loss of horizon, poor contrast between runway and grass and instrument reading difficulty. Most problems were satisfactorily resolved by using filters with good IR blocking capability, adding rubber eyecups to eliminate stray light and enhance contrast, adding a sunshade and blackening all metal surfaces. Satisfactory filters proved to be the readily available, inexpensive welder's goggle lenses (shade 12 for overcast days, shade 14 for sunny days). The addition of cross-polarizers is recommended for variable density adjustment. Army-wide standardization of a daytime filter assembly for NVG training is currently under consideration.

Papers Published:

Behar, I., Night Visiion Goggle, AN/PVS-5, Modification for Daytime Training. USAARL Letter Report No 77-7-7-2, June 1977.

Behar, I., Night Vision Goggle Training in the 2B31 Synthetic Flight Trainer Simulator. USAARL Letter Report No. 78-6-7-4, November 1977.

Behar, I., Contrast Enhancing Eye Shields for Daytime Training with Night Vision Goggles, AN/PVS-5. USAARL Letter Report 78-17-7-7, June 1978.

Behar, I., Goniophotometric Evaluation of Land Light Diffusers for Night Vision Goggle Training. USAARL Letter Report 78-18-7-8, June 1978.

Papers to Scientific Journals:

Behar, I., Young, D. M., and Johnson, J. E. Training Requirements for Helicopter Operation With Night Visiion Goggles. AGARD Conference Report, Operational Helicopter Aviation Medicine, In Press

Ballistic Testing of Protective Eye Material

Statement of the Problem:

Numerous eye injuries occured in recent military engagements caused by fragments and spall which penetrated the goggles worn by ground vehicle crews. New materials are now available and require ballistic evaluation to insure that the soldier receives the maximum protection available.

Description of the Project:

A helium gas operated gun was fabricated in which the velocity of the projectile can be closely controlled and measured. Interchangeable barrels are employed which accomodate spherical steel balls up to 1/4 inch in diameter (17 grain). The lenses are mounted in standard issue frames and are tested on a head form.

Progress, Status and Results:

Using 2mm thick polycarbonate lenses mounted in an S-10 zyl frame, the mean penetration velocity was 850 ft. per second with a one inch steel ball. The breaking point of heat treated glass, also two mm thick, and using the same size projectile was 39 ft. per second. The currently issued plastic lens, CR39, under the same conditions, failed at 128 ft. per second. If the material is increased in thickness to three mm, the breaking points are 1100 ft per second for polycarbonate, 161 ft. per second for CR39 plastic and 59 ft. per second for heat treated glass. With the advent of the scratch resistant coatings for polycarbonates, a strong recommendation must be made for its use by the soldier exposed to high speed fragments.

Haze Evaluation by Visual Modulation Transfer Function (VMTF) Criterion

Statement of the Problem:

The aim of this project is to provide an actual data base relating percent haze to visual performance decrement using the precisely quantifiable VMTF as the criterion visual task.

Description of the Project:

Plastic optical components, such as windscreens, visors and goggle and protective mask lenses, have the property, to varying degrees, of scattering in the forward direction (as well as backscattering) some of the light incident on their surface. This property is called haze and the maximum allowable percent haze (MAPH) value is specified in AMST, ANSI, Federal Standards and Military Specifications. The MAPH value varies for different materials and applications and presumably is related to the maximum allowable loss in visual capability.

The allowable haze value, for various Standards and Specification is as little as 1% (MIL-G-25667B, 1970) and as high as 6% (ANSI Z87.1-1968). Only one study, that of Glover, could be found in an extensive literature search, that attempted to establish allowable limits based upon measurable visual performance decrement. Glover, however, failed to present his data, merely indicating that 0.5% is the maximum desirable limit while 2% should be the maximum allowable.

Progress, Status and Results:

Instrumentation for this project is being developed. Data collection is being delayed for lack of professional and technical manpower time.

Papers Published:

None.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA 0B 6892	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISB'N INSTR'N	8b. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73A	3E162773A819	00	003
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS (f) (m)			

11. TITLE (Precede with Security Classification Code)

(U) Research of Electro-Optical Systems and the Human Visual System

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 012000 Optics; 012900 Physiology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-house

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	3.75	131
	CURRENT 79	4.0	93,000

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory

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MILITARY RELEVANCY CERTIFIED UNDER SECTION 284 (FY) - FUNDS

BY R O Sprague

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20. PERFORMING ORGANIZATION

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ASSOCIATE INVESTIGATORS

NAME: Holly, F.F., CPT

NAME:

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Aircraft; (U) Electro-Optical Systems; (U) Vision; (U) Target Detection; (U) Display Color; (U) Visual Sensitivity; (U) Night Vision

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information about the effects of military electro-optical viewing and display systems on the human visual system and to determine optimum display characteristics to match the capabilities of the visual system.

24. (U) The approach will involve visual psychophysical procedures and the electro-optically generated targets will be verified with static and scanning photometric and colorimeteric techniques.

25. (U) The instrumentation necessary to measure and record the visual display parameters, a spatial and spectral scanning radiometer/photometer, has been used successfully for the past year. A video pattern generator used to generate dynamic and static waveforms is also being modified to increase its flexibility. The motion picture system and flying spot scanner used to transform film imagery to video are also being modified for computer operation. These devices are to be used to present dynamic and film stimuli respectively, to the observer's display. A display drive electronics unit and four miniature CRT's with P-1 (green), P-43 (green), P-22 (red), and P-45 (white) phosphor used to acquire data for the first study will be used for the remaining studies if the large panel display ordered last year cannot meet specifications. The seven large CRT's and three sets of driving electronics have encountered manufacturing problems. The first unit is to be delivered in November 1978, nine months behind schedule, for acceptance testing. Optics for the miniature and panel display have been received and accepted. The software and computer interface for the studies are completed and are being debugged. The results of the first study, presented at the Society of Information Display Symposium, indicate there is no contrast sensitivity differences in the four phosphors listed for the conditions tested. This project has unfunded requirements of 0.65 man-years and $15,013.

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Research of Electro-Optical Systems and the Human Visual System

Statement of the Problem:

The efficiency of the mandisplay system is critical if the man is to acquire all the electronic information the expensive electro-optical sensors and data systems are providing. The display characteristics interact with, and therefore, must be analyzed in concert with the human visual system to maintain meaningful and realistic mandisplay performance measures.

Description of the Project:

The mandisplay performance for a variety of cathode ray tube (CRT) displays are being measured and evaluated. The criteria used to measure the mandisplay performance include: contrast sensitivity for stationary and moving stimuli; subtended visual angles; and dark adaptation rates. In order to relate these theoretical criteria to real world criteria, tactical recognition tests are also being conducted. Subjective data from the subjects are also obtained which show their own preference.

The independent variables being investigated are: phosphor color, phosphor persistence; screen and surround luminance; contrast ratios; and viewing time. The effects of parameters such as focused and collimated monocular, biocular, and binocular viewing systems on fatigue rates, retinal rivalry, and depth perception are also being investigated. Static and dynamic sine wave responses are used to relate criteria measures to measurable physical display quality.

Status:

The instrumentation necessary to measure and record the visual display parameters, a spatial and spectral scanning radiometer/photometer, has been used successfully for the past year. Modifications are currently being made to interface this instrument with the hybrid computer for more flexibility in handling its data output. A video pattern generator used to generate dynamic and static waveforms is also being modified for computer operation. These devices are to be used to present dynamic and film stimuli, respectively, to the observer's display. A display drive electronics unit and four miniature CRT's with P-1 (green), P-43 (green), P-22 (red), and P-45 (white) phosphors used to acquire data for the first study will be used for the remaining studies if the large panel display ordered last year cannot meet specifications. The seven large CRT's and

three sets of driving electronics have encountered manufacturing problems. The first unit is to be delivered in November 1978, nine months behind schedule, for acceptance testing. Optics for the miniature and panel display have been received and accepted. The software and computer interfaces for the studies are completed and are being debugged. The results of the first study, presented at the Society of Information Display Symposium, indicate there is no contrast sensitivity differences in the four phosphors listed for the conditions tested.

Publications:

None

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA OC 6885	78 11 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8b. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	H. TERMINATION	U (NO CH)			NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	21X4992	7KE80130	00	017
b. CONTRIBUTING	6.27.73.A	3E762773A819		
c. CONTRIBUTING	CARDS (f) (m)			

11. TITLE (Precede with Security Classification Code)*

(U) Bio-Optical Aspects of the XM-29 Protective Mask

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

012000 Optics; 012900 Physiology; 001300 Aircraft

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 07	Cont	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:* Not applicable

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (in thousands)
FISCAL YEAR PRECEDING 78	0.3	16
FISCAL YEAR CURRENT 79	0	0

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory

ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: KNAPP, Stanley C., COL, Cdr

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory
Human Tolerance & Survivability Div

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* WILEY, R. W., MAJ

TELEPHONE: (205) 255-6808/6415

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: GLICK, D. D., MAJ

NAME:

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Protective Mask; (U) Bio-Optical Evaluation; (U) Ophthalmic Correction

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide information and guidance of visual and optical aspects in the design and fabrication material of the XM-29 protective mask.

24. (U) The approach will include physical optics techniques, photometry, and spectrophotometry to measure the optical quality of images transmitted through the mask, and psychophysical techniques will be used to measure visual performance while wearing the mask. The effort will include a consideration of techniques to provide optical correction in the mask for those individuals with refractive errors.

25. (U) Problems encountered by the mask developer in providing a suitable optical surface and an effective coating led to indefinite delays in the development cycle. The development of the associated combat spectacle will be continued at the Biomedical Laboratory.

*Available to contractors upon originator's approval.

Combat Spectacle Frame

Statement of the Problem:

Historically, the combat soldier was not issued a spectacle frame designed for rugged use. This resulted in excessive breakage during combat and the loss of the soldier to his unit while repairs were being made. In addition, glasses were not compatible with protective masks. This required removal of the spectacles, again risking breakage and loss, and the use of an optical insert in the mask. Inserts have never worked well for either the user or the lens fabricator.

Description of the Project:

The Chemical Systems Laboratory and the Biomedical Laboratory requested our assistance in the design and field testing of a suitable frame.

Status:

A frame was designed and field tested in FY 78. An improvement to the head strap is currently under way at the Biomedical Laboratory. They are expecting the final product to be ready in the 3rd Quarter, FY 79.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA 0B 6895	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8A. DISP'N INSTR'N	8B. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	U	U	NA	NL	[X] YES [ ] NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162773A819	00	007
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code)* (U) Aviation Medicine Research for Aircrew Selection, Retention, and Physical Performance Standards

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 001300 Aircraft; 012900 Physiology; 016200 Stress Physiology; 002300 Biochemistry; 012400 Personnel Selection & Maintenance; 009400 Man-Machine Relatio

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:*
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	1.75	47
	CURRENT 79	5.8	206

19. RESPONSIBLE DOD ORGANIZATION
NAME:* US Army Aeromedical Research Laboratory
ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, CDR
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION
NAME:* US Army Aeromedical Research Lab
Human Tolerance & Survivability Div
ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME:* Wiley, R.W., MAJ
TELEPHONE: (205) 255-5114
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Kessler, Jeffrey B., CPT
NAME:

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Pulmonary Physiology; (U) Stress Physiology; (U) Pharmacology; (U) Life Support

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide the US Army information concerning the medical requirements for Army aircrew selection, retention, and physical performance.

24. (U) To apply accepted medical research methodology and technology to accomplish the objective.

25. (U) 77 09 - 78 09 Progress on this project has been limited by personnel attrition during the past year as reflected in the reduction of actual resources (professional man-years and funds) used from that which had been programmed. Accomplishment is shown by completion of the laboratory investigative phase of the pathophysiology of exposure to carbon monoxide. Emphasis was placed on the interaction of carbon monoxide and flight altitude. Results are reported in USAARL Report 78-7, "The Interaction of Carbon Monoxide and Altitude on Aviator Performance: Pathophysiology of Exposure to Carbon Monoxide." The field evaluation of oxygen masks for US Army aircrew continues The MBU-12/P mask which is considered as a possible replacement for the A-13A mask presently issued has been distributed to operational aviation units in Korea and Germany for field evaluation. This project has unfunded requirements of 3.0 man-years and $48,900.

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MILITARY RELEVANCY CERTIFIED UNDER SECTION 204 (FY ..... FUNDS)
BY .....

* Available to contractors upon originator's approval

DD FORM 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

Effect of Oxygen and Carbon Monoxide on Physiologic Parameters

Statement of the Problem:

Carbon monoxide has been recognized as a threat to aircrews since the early days of flight. Increasingly sophisticated aircraft and engines have provided the potential for a myriad of carbon monoxide exposures. This fact in conjunction with altitude-induced hypoxia and smoking provides the current US Army aircrewman with an insidious and life-threatening environment. The operational aviator as well as the research and development community needs a basic understanding of the pathophysiology of carbon monoxide exposure in man.

Description of the Project:

A reappraisal of the interaction of carbon monoxide and altitude was accomplished in light of current concepts of the pathophysiology of low level exposure to carbon monoxide. The review included a consideration of: (1) the potential sources of carbon monoxide; (2) the factors affecting the absorption, transport, and elimination of carbon monoxide; (3) the effects of carbon monoxide on human health and cognitive function; (4) the interaction of carbon monoxide and altitude, and resulting hypoxia; (5) the concept of equivalent physiological altitudes; (6) predictable effects of transcient elevation in carbon monoxide; (7) limits of carbon monoxide exposure; and (8) the basic pathophysiological changes occurring with hypobaric hypoxia and/or carbon monoxide hypoxia.

Status:

The initial laboratory analysis phase of this project has been completed and the results have been published. Data are presented which show that the modest smoker with 7% carbon hemoglobin in his blood and flying at an actual altitude of 5,000 feet is actually flying at an equivalent physiological altitude of 10,500 feet. The performance decrement associated with this hypoxic state may represent the critical loss in operational skill required to accomplish the mission in a combat environment. Continued research into the physiologic and psychologic effects of carbon monoxide exposures on performance is planned.

Publications:

The results of this project have been published in USAARL Report 78-7, "The Interaction of Carbon Monoxide and Altitude on Aviator Performance; Pathophysiology of Exposure to Carbon Monoxide", April, 1978.

Papers to Scientific Journals:

Denniston, J. C. and Pettyjohn, F. S., "Carbon Monoxide and the Heart: A Review and Update," Veterinary Corps Newsletter, In Press.

Denniston, J. C., Pettyjohn, F. S., Kelliher, J. C., and Boyter, J. K., "Interaction of Carbon Monoxide and Altitude on Aviators: A Review and Update," Aerospace Medicine Association Preprints, pp. 62-63, 1978.

Pettyjohn, S., Denniston, D. C., and Boyter, J. K., "Carbon Monoxide and the Aviator (or What Altitude did you reach from one Cigarette?)" US Army Aviation Digest, 24: 28-31, 1978.

Evaluation of Oxygen Masks for US Army Aircrew

Statement of the Problem

The US Army aircrewman currently uses the US Army A-13A oxygen mask developed in the late 1940 time frame. The A-13A is furnished in three sizes only. Preventive maintenance and operational checks prior to flight do not occur in the absence of an Army life support equipment system. Advances in the state-of-the-art have provided improvements in weight, helmet attachment, composite shell/mask, and inhalation/exhalation valves. This study was initiated to evaluate the USAF MBU-12/P and RAF P/Q mask for compatibility and function with US Army aircrew equipment.

Description of the Project:

This project originated from numerous complaints from the field of discomfort ans some incompatibility of the presently issued A-13A mask with new and proposed cockpit instrumentation. Thirty-eight (38) MBU-12/P masks, which are currently issued by the US Air Force and US Navy, were obtained and distributed to operational INSCOM aviation units in Korea and Germany for field testing and evaluation for compatibility and performance. MBU-12/P masks have also been provided to Army helmet designers to determine compatibility with the fit, attachment, and communication system of the SPH-4 helmet.

Status:

Progress on this project has been compromised because of the loss of key investigative personnel. At present, the field testing units have been contacted to insure adequate data flow from the field tests. No report has yet been received concerning the compatibility of the MBU-12/P mask with the SPH-4 helmet.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA0B 6894	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	H. Term	U (No Ch)				☐ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162773A819	00	006
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114(f)(m)			

11. TITLE (Precede with Security Classification Code)

(U) Medical Research of Operational Problems in Army Aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS 001300 Aircraft; 016200 Stress Physiology; 016800 Toxicology; 008800 Life Support; 017100 Weapons Effects; 009400 Man-Machine Relations

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	Cont	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: N/A
d. AMOUNT:
e. KIND OF AWARD:
f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	10.5	310
FISCAL YEAR CURRENT 79	0	0

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory
ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab
Fld Rsch & Biomed Appl Div
ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME: Barden, R.R., LTC, MSC
TELEPHONE: (205) 255-5107
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Hiott, B. F., T/SGT
NAME: Whitehurst, L. R., MAJ

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Aircraft; (U) Biochemistry; (U) Clinical Medicine; (U) Life Support; (U) Pharmacology; (U) Stress Physiology; (U) Toxicology; (U) Oxygen

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide the US Army information and recommendation for protection of aviator health from medical hazards encountered in operational Army aviation.

24. (U) To apply accepted medical research methods in Army aviation to fulfill the above objective.

25. (U) 77 10 - 78 09. In-flight data on the Army Molicular Sieve Oxygen Generator System (AMSOG) has proven the overall reliability and validated the physiological aspects of its delivery capability. The initial AMSOG units have been returned to the respective manufacturer for modification and addition of improved components. All phases of this project are terminated.

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DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

Medical Research of Operational Problems in Army Aviation

Statement of the Problem:

To develop and to evaluate advanced oxygen systems for Army aircraft.

Description of the Project:

There is a continually increasing need for Army aircraft to routinely have on-board oxygen systems that do not impose a weight penalty above current gaseous systems and provide a continous supply of oxygen at a rate and volume adequate for crewmembers, patients, and passengers. New aircraft fly faster, higher and are considered to be readily available to operate in both a NOE and high altitude environment. The molecular sieve technology continues to provide a more feasible means of generating oxygen on Army aircraft than the chlorate candle or other chemical systems.

Progress, Status and Results:

Two molecular sieves were evaluated in the JU-21G and JOV-1B aircraft with emphasis skewed to one particular type. A chlorate candle system was evaluated in the JU-21G and JUH-1H. Two candle systems were distributed to the field for rate data, maintenance and acceptability. The two molecular sieve systems have been returned to the respective manufacturer for modification and upgrading of some components.

List of Publication:

None.

Papers to Scientific Journals:

None.

Aeromedical Evaluation (Anthropometry, Thermal, Toxic Gas Analysis) of Current and Future Rotary and Fixed Wing Aircraft, Vehicles and Weapons Systems

Statement of the Problem:

USAARL has provided "quick fix" evaluations for hazardous medical conditions discovered after aircraft have entered the Army. A more reasonable approach would be to give medical input into future aircraft design. Operational requirements have required the development of technology and methodology for evaluation of current and proposed aircraft, vehicles and weapons systems to include anthropometry, downwash, heating, ventilation and toxicology. USAARL has been asked to aeromedically evaluate the UTTAS, the 214A helicopter, the Casey heater modification of the OH-58, the Dragon anti-tank weapon and others.

Description of the Project:

Anthropometry measurements utilized standard human factor engineering techniques. Downwash ventilation studies are performed using calibrated Alnor flowmeters. Heating data is obtained by YSI wet-dry-radiant heat thermocouples. Mass spectrometry and infra-red spectrometers are used for toxic cabin contaminants.

Anthropometric and downwash studies were accomplished for the Boeing and Sikorsky UTTAS helicopter prototypes and the Bell 214A helicopter. Evaluation of heating and ventilation for these aircraft was accomplished using available YSI thermocouples and Alnor flowmeters. To accurately evaluate toxic contaminants due to armament firing and engine exhaust, development of on-line sampling techniques by mass spectrometer was required.

A 20 meter cell portable infra-red spectrometer is used to increase the toxic gas spectrum quantification. The selected UTTAS (UH-60A) was reevaluated following modification to improve ventilation and washout of gun gas accumulation. Gas analysis techniques are continually evolving. We are constantly striving to improve our methodology for gas analysis by purchasing new equipment such as the Mine Safety Appliance carbon monoxide detector and the Energetics Sciences analyzer for NO and H_2S.

Progress, Status and Results:

The Dragon anti-tank weapon data has been analyzed and completed. The laboratory report is complete. USAARL was tasked by the Minnesota Air National Guard to evaluate a casey cold weather heater modification to the OH-58. The task was completed and a letter report written.

An evaluation of exhaust contamination of the CH-54 troop carring POD during airborne operations was accomplished.

New techniques for gas sampling are being developed for use with the mass spectrometer. Tenax is being used as a material to trap gases as air is pumped through the trap. Tenax is reported to be a better trapping agent than charcoal which was previously used.

A vacuum system is being constructed in order to create gas standards in our laboratory.

Planning has been initiated for application of these analytic methodologies to future helicopters (AAH, ASH), tanks (XM-1), weapons systems (missiles, rockets), and specific ground combat operational scenarios [Military Operations in built-up areas (MOBA)]. Collection systems have been designed to meet the requirements of sampling in flight, in moving combat vehicles, and during weapons firing. The MS-GC and IR studies to date have provided the background technologic base for evaluation of critical total weapons systems to maximize crew performance and monitor limits.

List of Publications:

Schumaker, R. L., Pollard, G. D. Toxicologic Gas Evaluation of the Utility Tactical Transport Aircraft System (UH-60). USAARL Report No. 77-18.

Pollard, G. D., Piper, C. F., Denniston, J. C. Toxic Gas Analysis Evaluation of the Casey Heater. USAARL-LR-78-11-1-1.

Pollard, G. D., Boyter, J. K., Watson, J. Evaluation of Dragon Anti-Tank Weapon for Toxic Gases While Firing from an Enclosure. USAARL Report No. 78-13.

Pollard, G. P., Hiott, B. F., Denniston, J. C. Evaluation of Exhaust Contamination of the CH-54 Troop Carring POD During Airborne Operations. USAARL-LR-78-12-1-2.

Reports in Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA 0B 6898	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISS'N INSTR'N	8b. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	U	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162773A819	00	008
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114 (f) (m)			

11. TITLE (Precede with Security Classification Code)* (U) Aeromedical Evacuation, Rescue, and Life Support Equipment and Applications

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 003300 Clinical Medicine; 006000 Escape, Rescue & Survival; 008800 Live Support; 012900 Physiology; 009800 Medical & Hospital Equipment; 009400 Man-Machine Relations; 016500 Telemetry

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	CONT	DA	C. In-House

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:*
c. TYPE: N/A
d. AMOUNT:
e. KIND OF AWARD:
f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	3.5	84
FISCAL YEAR CURRENT 79	3	241

19. RESPONSIBLE DOD ORGANIZATION
NAME:* US Army Aeromedical Research Lab
ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION
NAME:* US Army Aeromedical Research Lab
ADDRESS:* Fld Rsch & Biomed Appl Division
Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME:* Kimball, Kent A., Ph.D.
TELEPHONE: (205) 255-3211
SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS
NAME: Sanders, M.G., Ph.D.
NAME: Duncan, C.E., CPT, MSC

21. GENERAL USE
Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Helicopter Ambulance; (U) Emergency Medicine; (U) Clinical Medicine; (U) Life Support; (U) Resuscitation; (U) Rescue; (U) Medical Equipment

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide the US Army helicopter and fixed wing aeromedical evaluation up-to-date information on compatible medical rescue/life support equipment and techniques to insure advanced and rapid definitive medical treatment of the combat casualty.

24. (U) To apply accepted medical and biomedical research methodology and technology to accomplish the above objective.

25. (U) 77 10 - 78 09. Progress under the project has been made in one major area. An operational test of the Western Gear hoist has begun in conjunction with the USA Aircraft Development Test Activity at Fort Rucker, AL. After only four flights with the Western Gear hoist, a total of approximately 9 flight hours, the hoist failed internally. Determination will be made at the manufacturer's factory as to the cause of the failure. A total of approximately 90 flight hours will be required to evaluate the hoist.

MILITARY RELEVANCY CERTIFIED UNDER SECTION 204 (FY ..... FUNDS)
BY Signed
William R. Forsyth

*Available to contractors upon originator's approval

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.

The Helicopter Air Ambulance in Aeromedical Evacuation and Rescue--Equipment and Aircrew Interface

Statement of the Problem:

Helicopter aeromedical evacuation has succeeded in reducing the mortality of soldiers in the Republic of Vietnam to its lowest level of 2.3%. Further efforts to improve this figure require improved medical care in the helicopter air ambulance at the earliest possible time, i.e., immediate resuscitation and life support at time of pick up and during initial aeromedical evacuation.

Description of the Project:

Evaluation of medical equipment, interface of air ambulance aidman for helicopter use, and changing mission concepts of aeromedical combat and peacetime evacuation is an ongoing process. Evaluation of the rapidly advancing technology of emergency medical care equipment is being conducted on a continuing basis to assess its application to the helicopter environment and utility in combat casualty care.

Progress, Status and Results:

Progress under the project has been made in one major area. An operational test of the Western Gear hoist has begun in conjunction with the USA Aircraft Development Test Activity at Fort Rucker, AL. After only four flights with the Western Gear hoist, a total of approximately 9 flight hours, the hoist failed internally. Determination will be made at the manufacturer's factory as to the cause of the failure. A total of 90 flight hours will be required to evaluate the hoist.

Papers Published:

None.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DAOD 6738	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8a. DISP'N INSTR'N	8b. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	(U) No Ch			NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162773A819	00	009
b. CONTRIBUTING				
c. CONTRIBUTING	CARDS 114(f)(m)			

11. TITLE (Precede with Security Classification Code)

(U) Research Psychology Applied to Medically Significant Problems in Army Aviation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS

001300 Aircraft; 009400 Man-Machine Relations; 013400 Psychology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
65 02	CONT	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:
c. TYPE: N/A
d. AMOUNT:
e. KIND OF AWARD:
f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	3	95
FISCAL YEAR CURRENT 79	3	254

19. RESPONSIBLE DOD ORGANIZATION

NAME: US Army Aeromedical Research Laboratory

ADDRESS: Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL

NAME: Knapp, Stanley C., COL, Cdr

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME: US Army Aeromedical Research Lab
Fld Rsch & Biomed Appl Div

ADDRESS: Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME: Kimball, Kent A., Ph.D.

TELEPHONE: (205) 255-3211

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Armstrong, R.N.

NAME: Krueger, G.P., CPT, MSC

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Man-Machine Relations; (U) Military Aircrafts; (U) Human Factors Engineering; (U) Psychology; (U) Human Volunteers; (U) Recording Devices; (U) Stress; (U) Simulators; (U) Computers; (U) Aeronautics; (U) Safety Engineering

23. TECHNICAL OBJECTIVE, 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide US Army aviation information that is medically important about the human factors in the aircraft man-machine system with special emphasis on the performance of these muman factors and the variables that influence them.

24. (U) The approach will involve the application of current research techniques applicable to the objective as well as developing new techniques as required.

25. (U) Progress under this work unit includes the completion of laboratory reports: "Human Factors Evaluation of the CH-47C Synthetic Flight Training System (2B31)," "An Evaluation of Perceptual-Motor Workland During a Helicopter Hover Maneuver," and presentation of the following papers to the NATO-AGARD and to the Aerospace Medical Association. Oculomotor Performance of Aviators During an Autorotation Maneuver in a Helicopter Simulator, Changes in the Rotary Wing Aviator's Ability to Perform an Uncommon Low Altitude Rearward Hover Maneuver as a Function of Extended Flight Requirements and Aviator Fatigue, Army Aviation Fatigue Related Accidents: 1971-1977, An Evaluation of the Effects of a Stability Augumentation System Upon Aviator Performance/Workload During a MEDVAC High Hover Operation. Research personnel have completed the conduct of two helicopter simulator experiments; have initiated work on literature surveys on work/rest cycles, sleep deprivation fatigue and sustained operations as they affect aviator performance and on heads-up and helmet mounted sights and displays; have conducted a survey of aviator fatigue related accidents; have provided technical inputs to several aviation development programs, working panels and groups including: AH, ASH, UTTAS, CH-47 Simulator, Doppler Nav System, TRADOC Concept Eva Program, Tri-Service Group on Helicopter Medicine, Human Resources, Human Factors Research, and in the Determination of Minimum Requirements for Army Aviators.

MILITARY RELEVANCY CERTIFIED UNDER

*Available to contractors upon originator's approval

SECTION 204 (FY FUNDS)

DD FORM 1 MAR 66 1498

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.

Aviator Performance during Hover with a Stability Augmentation System

Statement of the Problem:

The objective of this research is to evaluate the effects of a stability augmentation system upon aviator and performance/workload during a high hover operation. Our goals were to determine if the device of concern could provide a more stable platform and enhance mission performance and reduce workload in critical MEDEVAC operations.

Description of the Project:

Successful completion of the Army medical mission requires that the MEDEVAC aviator be capable of performing precise stabilized hovers during the estraction of injured personnel. The precision hover is one of the most difficult and taxing flight maneuvers. The potential severity of this mission-essential maneuver, when high altitudes, adverse weather, and immediate threat factors are considered, required expedient execution. The current research examines a method of aiding the MEDEVAC pilot in the performance of a hover maneuver while perhaps reducing workload. Stability augmentation systems are purported to reduce pilot workload during hover, NOE, and IFR maneuvers. In 1975, an agreement was made such that the Fort Eustis Air Mobility Laboratory would provide this laboratory with the Kaiser Mini-Stab, which had been a candidate for UH-1H MEDEVAC missions. In return, the Air Mobility Lab could use the UH-1H helicopter for their subjective flight evaluation of the stability augmentation system. Our efforts were pointed toward an objective evaluation of the Mini-Stab with the Helicopter In-Flight Monitoring System.

Progress, Status and Results:

The project described above is complete.

List of Publications:

The results of the study have been presented at the NATO Advisory Group for Aerospace Research and Development (AGARD), Fort Rucker, AL, May 1978 and

Aerospace Medical Association, 49th Annual Scientific Meeting, New Orleans, LA, May 1978. The study has been published as a USAARL Lab Report No. 78-14, May 1978.

Papers to Scientific Journals:

Submitted to the Human Factors Journal for publication in the open literature. This article has been accepted for publication pending rewrite of the introduction section for a more generalized approach so that subject matter would appeal to a greater range of reader interests.

Aviator Oculomotor Performance in Simuhims

Statement of the Problem:

The helicopter is an integral part of the tactical structure and is continuing to receive expanded missions. Although audio and tactile stimuli are utilized, the aviator still relies in large measure on visual information for aircraft control. This information, under visual flight rules (VFR), is obtained from sources within the cockpit as well as viewing outside the aircraft. However, when flying under instrument meteorological conditions (IMC) or restricted visibility such as night, more, if not all, cues required for appropriate aircraft control and management must be obtained from the aircraft instrument panel. In the past, and also persistent in future helicopter design, is the concept that fixed wing instrument and instrument arrangements provide the rotary wing aviator with adequate visual information transfer, However, in light of pilot opinion, accident reports and limited objective data, it would appear that this concept should be challenged. This investigation will permit data collection with regard to visual cues necessary for IFR helicopter maneuvers, thus providing a partial data base useful for optimal panel design.

Description of the Project:

Visual and psychomotor performance will be measured in the USAARL helicopter simulator during basic IFR helicopter maneuvers. These data will be compared to similar data obtained in the 2B24 helicopter simulator and UH-1 helicopter. In addition to expanding the objective data base, this study will provide the above mentioned comparisons.

Progress, Status and Results:

Two research studies have been conducted to date.

a. Aviator performance during precision instrument flight in a UH-1 simulator.

b. Psychomotor and oculomotor performance of aviators during precision instrument flight in a UH-1 helicopter simulator.

Data has been collected on ten Army aviators in each of these studies while flying precision instrument flight profiles. Various categories of flight control performance and eye movement data were collected. These data will be evaluated with respect to aviator psychomotor and oculomotor performance. The data analysis phase of these projects is in process.

List of Publications:

Armstrong, R., G. Krueger, J. Sapp and Y Jones. Oculomotor Performance of Aviators during an Autorotoation Manuever in a Helicopter Simulator, presented at the Advisory Group for Aerospace Research and Development (AGARD) Medical Panel Specialists' Meeting on Operational Helicopter Aviation Medicine, Fort Rucker, AL May 1978.

Armstrong, R., G. Krueger, J. Sapp, and Y. Jones. Oculomotor Performance of Aviators during Autorotation Maneuvers in a Helicopter Simulator, presented at the 49th Aerospace Medical Association Meeting, New Orleans, LA, May, 1978.

Papers to Scientific Journals:

None.

Flight Time and Crew Rest Requirements for Initial Entry Rotary Wing (IERW) Training and Selected Combat Missions

Statement of the Problem:

The objective of this study is to provide data in the form of subjective estimates of the appropriate flight time and crew rest requirements for the different phases of IERW training and selected combat missions.

Description of the Project:

Studies of flight time/crew rest related to rotary wing flight are few in number and inconclusive in their results. The amount of crew rest necessary is directly related to the degree of fatigue encountered during crew duty time. In a recent NATO AGARD report, "for the 50 accidents on which a full report was available, it was concluded that in some 20 percent, aviator fatigue was a major cause of the accident." The U.S. Army Agency for Aviation Safety (USAAVS) data indicate that for the FY 1969-73 period fatigue was cited as a factor in six percent of the rotary wing accidents and four percent of the fixed wing accidents. The question remains, how many other Army aircraft accidents were in part due to fatigue but were attributed to other factors such as: (1) failure to use accepted procedures. (2) selected wrong courses of action, (3) inadvertent operation selfinduced, (4) poor crew coordination, (5) inadequate coordination or timing, (6) misjudged speed or distance, (7) delay in taking necessary action, (8) distraction, (9) channelized attention, (10) task oversaturation, (11) inattention, and (12) confusion of controls, and others. US Army Aviation Regulation, AR 951, indicates that flight time limitations and crew rest requirements are established by local commanders. AR 951 provides the commanders with very few guidelines as to what might be appropriate. The proposed project will provide additional information concerning flight time and crew rest during IERW training and selected combat missions. Subjects will consist of IP's and student pilots. The flight time/crew rest questionnaire was developed in two forms one dealing specifically with IERW training, the other with combat missions. Both versions contain: (1) biographical information, (2) questions relating to flight time/crew limits for various periods of time across each training phase or combat mission, (3) rank ordering of phases or missions in terms of fatigue. (4) applicable factors contributing to fatigue for each phase or mission, and (5) a general comments section in which subjects could address any problems related to the project in detail.

Progress, Status and Results:

The data have been collected and analyzed and initial drafts of the methodology and results section have been completed. The project is currently in the interpretation and write-up phase. Very little progress has been made

on this project because of: (1) personnel departures without replacements, and (2) the priority of this project relative to other ongoing projects.

List of Publications:

None

Papers to Scientific Journals:

None.

Army Aviator Fatigue-Related Accident Survey

Statement of the Problem:

Aviator fatigue has been defined as being that state following a period of mental or bodily activity which is characterized by a lessened capacity for work and reduced efficiency of accomplishment accompanied by a feeling of worrying, sleepiness or irritability and subjectively felt as a desire or need for rest. For years aviator fatigue has been thought to have played a part in degrading aviator performance and as a major contributor to aviation accidents. Discussions of aviator fatigue continually arise in determining appropriate crew staffing ratios, planning military operations and insuring effective pilot performance and safety. The problem is to determine the conditions leading to aviator fatigue and to gauge the impact of fatigue in aviation safety and to identify important medical variables for flight surgeons who must advise aviation commanders on crew work-rest factors of operational flight schedules.

Description of the Project:

An accident data survey is being conducted to determine how frequently aviator crew fatigue contributes to Army aviation accidents. A computerized search of all accident reports in the U. S. Army Agency for Aviation Safety data base was conducted.

Progress, Status and Results:

Reports for fatigue=related accidents during the years 1971-1977 were studied. Technical papers summarizing these data were presented at the May 1978 NATO Advisory Group for Aerospace Research and Development (AGARD) Aerospace Medical Panel Specialists' Meeting and at the Aerospace Medical Association, 49th Annual Scientific Meeting, also in May 1978. A laboratory technical report has been prepared. The technical report is being reviewed and prepared for submission to printing and will be completed early in FY 79.

List of Publications:

Krueger, G. and Y. Jones. Army Aviation Fatigue Related Accidents: 1971-1977. Presented at the NATO Advisory Group for Aerospace Research and Development (AGRAD) for R&D Aerospace Specialists' Medical Panel meeting on Operational Helicopter Aviation Medicine, Fort Rucker, AL, May 1978 and also at the 49th Aerospace Medical Association meeting, New Orleans, LA, May 1978.

Papers to scientific journals:

None.

Review of the Scientific Literature on Effects of Work/Rest Schedules, Fatigue and Sustained Operations on Aviator Performance

Statement of the Problem:

Aviation unit commander, aviation safety officers and flight surgeons are continually requesting scientific data which can be used in formulating flight limits and crew rest schedules in accordance with AR 95-1. Tacticians and conceptual strategists at DA level frequently ask for similar data to be used in planning crew staffing ratios in the development of Tables of Organization and Equipment and in making long range manpower determinations. Good scientific data which can be readily applied to answer these inquiries are just not available in one place.

Description of the Project:

A critical review of the scientific literature on the topics of work-rest schedules, fatigue and sustained operations as they pertain to aviator crew performance is being performed. Relevant data will be summarized in reports written for the above mentioned types of inquirers. Relevant gaps in the scientific data will be identified to provide direction for medical, psychological and physiological research programs on sustained Army helicopter operations.

Progress, Status or Results:

An annotated working research bibliography on work-rest cycles, sl deprivation, fatigue and sustained operations as they affect aviator performance is about 80% complete. Included are multidisciplinary articles which describe different methodological approaches and resultant data in the study of psychological, physiological, biochemical and ergonomic factors which relate to operator fatigue, performance and subjective and physiological state. The scientific review of this bulk of literature is going on simultaneously, subject to the time availability of pertinent personnel on the project (psychologists and flight surgeons).

List of Publications:

None.

Papers to Scientific Journals:

None.

The Effects of Prolonged Flight on Aviator Performance: Phase I

Statement of the Problem:

Changes in man-helicopter system performance resulting from extended flight requirements and aviator fatigue have a major impact on the aviation mission. The demand for precision performance for the flight crew increases with the use of terrain flight profiles and the addition of sophisticated target acquisition and weapons delivery systems. At the same time the aviator is required to fly long hours under stressful tactical conditions. Thus, the measurement of fatigue related changes in man-helicopter system performance is necessary to determine potential aviation mission impact resulting from extended flight requirements.

Description of the Project:

USAARL has conducted an extensive field investigation to measure aviator fatigue and changes in man-helicopter system performance. During this investigation six Army aviators completed five days of an extended flight schedule. During the inflight testing these aviators repeatedly executed a series of precision maneuvers. The phase one portion of this investigation concentrates on describing fatigue related changes in the man-helicopter system performance. Each of the specific maneuvers is treated individually.

Progress, Status and Results:

At the current time the data obtained from the 3 ft hover maneuver is being re-analyzed to implement the state of the art improvements in measurement of pilot control movements. In addition, this data is serving as the basis for development of practical fatigue and performance models for field application. These models will be updated from the analyses of the other maneuvers examined during the fatigue investigation. Much of the exploratory data analyses has been completed. The information required for the technical report is substantially complete (i.e., 70%) requiring only final analyses of the primary control dimensions.

Effect of Extended Flight Requirements and Aviator Fatigue on Precision Pedal Turn Performance:

An abbreviated report on the man-helicopter system performance during precision pedal turns was prepared and presented at the 1978 Aerospace Medical

Conference. This report is currently being expanded to provide a complete technical report. This project is considered to be 88% complete.

Effect of Extended Flight Requirements and Aviator Fatigue on Precision Rearward Hover Performance:

The results of this investigation were discussed in the 1978 NATO/AGARD ASMP Meeting presentation. This shortened version of the investigative results is being expanded into a complete technical report format. This project is considered 85% complete.

Effects of Extended Flight Requirements and Aviator Fatigue on Man-Helicopter Hover Performance:

The data obtained during the execution of precision hovers, at altitude, is currently being reviewed to accurately select those data samples which measure only the stabilized precision hover performance. At the completion of the data sample selection process, the performance results will be obtained through routine analysis procedures and the technical report developed. This project is 25% complete.

The Effects of Extended Flight Requirements and Aviator Fatigue on Helicopter In-Flight Performance (Traffic Patterns):

At this time several alternative methods are under consideration for use in segment flight selection and subsequent performance assessment. This development of standard performance criteria and segment selection for the various progressive activities involved in execution of the traffic pattern is a critical step in systematically describing the fatigue related changes in man-helicopter system performance. This project is 20% complete.

List of Publications:

Lees, M. A., Kimball, K. A., and Stone, L. W. "The Assessment of Rotary Wing Aviator Precision Performance During Extended Helicopter Flights." Paper presented at the NATO/AGARD Aerospace Medical Panel Specialists' Meeting, Cologne, Germany, April 1977.

Lees, M. A., Kimball, K. A., and Stone, L. W. "The Assessment of Rotary Wing Aviator Precision Performance During Extended Helicopter Flights." Paper presented at the 21st Annual Conference of the Human Factors Society, San Francisco, CA, October 1977.

Lees, M. A., Simmons, R. R., Stone, L. W., and Kimball, K. A. "Changes in the Rotary Wing Aviator's Ability to Perform an Uncommon Low Altitude Rearward Hover Maneuver as a Function of Extended Flight Requirements and Aviator Fatigue." Paper presented at the NATO/AGARD Aerospace Medical Panel Specialists' Meeting, Ft. Rucker, AL, April 1978.

Lees, M. A. "The Effect of Extended Flight Requirements and Aviator Fatigue on Rotary Wing Precision Pedal Turns and Rearward Hover." Paper presented at the 1978 Scientific Meeting of the Aerospace Medical Association, New Orleans, LA, May 1978.

Papers to Scientific Journals:

None.

The Effects of Prolonged Flight on Aviator Performance: Phase II

Statement of the Problem:

The major role that aviator fatigue may play in reducing mission accomplishments requires that flight commanders have the capability to make objective judgments regarding current levels of aircrew fatigue. To satisfy his responsibility, the local flight commander requires relevant information regarding the impact of aircrew fatigue on mission accomplishment and practical fatigue measures with which to assess current levels of aircrew fatigue.

Description of the Project:

This portion of the research investigiation (phase II) has the primary goal of identifying practical measures of aircrew fatigue. These measures must be sensitive indicators of the aviator's current ability and must be correlated with observed changes in the man-helicopter system performance. This research project simultaneously compares physiological, biochemical, psychomotor and subjective measures of fatigue and performance to determine which tests best reflect changes in man-helicopter system performance observed during the field investigation described in the Phase I Summary.

Progress, Status and Results:

A technical report entitled "The Measurement of Man-Helicopter Performance as a Function of Extended Flight Requirements and Aviator Fatigue" is being developed to provide a central source, describing the field investigation, the experimental design considerations, and the data reduction and analyses processes. This report is currently in a rough draft stage and is approximately 80% complete.

Currently, parailel efforts are in process to analyze both the subjective rating scales and the results obtained from biochemical analyses. Preliminary analysis of the subjective scores is nearly completed. Data reduction of the biochemical results is still in progress. Final data reduction will require consultative assistance.

List of Publications:

Kimball, K. A. and Anderson, D. B. Aviator performance: Biochemical, physiological, and psychological assessment of pilots during extended helicopter flight. NATO/AGARD Conference Proceedings No. CP-180, October 1975.

Reports in Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA OB 6899	78 09 15	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISB'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. CHANGE	U (No CH)	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.11.01.A	3A761101A91C		294
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)*
(U) Operational Measures of In-Flight Performance

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*
009400 Man-Machine Relations; 013400 Psychology; 001300 Aircraft

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
74 07	Cont	DA	C. In-House

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:* N/A
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	2.5	55
	CURRENT 79	2.5	55

19. RESPONSIBLE DOD ORGANIZATION
NAME:* US Army Aeromedical Research Laboratory
ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: Knapp, Stanley C., COL, Cdr
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION
NAME:* US Army Aeromedical Research Lab
Aviation Psychology Division
ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME:* Kimball, K. A., Ph.D.
TELEPHONE: (205) 255-3211
SOCIAL SECURITY ACCOUNT NUMBER:

21. GENERAL USE
Foreign Intelligence Considered

ASSOCIATE INVESTIGATORS
NAME: Sanders, M.G., Ph.D.
NAME: Lees, M. A., CPT

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Human Factors Engineering; (U) Military Aircraft; (U) Man-Machine Relations; (U) Psychology; (U) Human Volunteers; (U) Recording Devices;

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

(U) Aeronautics

23. (U) To investigate, in the operational environment, variables which effect aviator performance.

24. (U) The approach will involve the utilization of an in-flight monitoring and recording system capable of sampling and recording nineteen channels of continuous analog and digital information, and an oculomotor device for eye movement recording during flight. Research which will be completed as a result of resources allocated under this work unit will be aviator oculomotor performance in UH-1H during nap-of-the-earth flight; aviator oculomotor performance during IFR flight; a comparative study of fixed and rotary wing aircraft; and map compatibility for night navigation with and without the AN/PVS-5 night vision goggles.

25. (U) 7710-7809. Progress under this work unit is referenced by topic as follows: "Aviator Oculomotor Performance in UH-1H During Nap-of-the-Earth Flight," work completed and documented in USAARL Report No. 78-5. "A Comparative Study of Fixed and Rotary Wing Aircraft," project is in the data reduction phase. Work related to this effort presented at Aerospace Medical Association entitled "Aviator Visual Performance: A Comparative Study of a Helicopter Simulator and the UH-1 Helicopter." "Aviator Oculomotor Performance During IFR Flight," work completed and presented at Aerospace Medical Association under title "Visual Performance/Workload of Helicopter Pilots During Instrument Flight." "Map Compatibility for Night Navigation With and Without AN/PVS-5 NVG," requests for prototype maps from Defense Mapping Agency have been made. Project will continue as maps are acquired.

*Available to contractors upon originator's approval

MILITARY RELEVANCY CERTIFIED UND

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A 1 NOV 63 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.

SECTION 204 (FY FUNDS)
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Aviator Visual Performance in JUH-1H Helicopter Under Visual Flight Rules (VFR)

Statement of the Problem:

Evolving from the Army's modern airmobility concept, the helicopter has become a strategic element of the tactical structure. The pilot's ability to manipulate his aircraft in the tactical setting is directly related to the inputs or cues he receives from the flight environment. Of the perceptual inputs required to fly the aircraft visual cues are considered vital. This work will provide information concerning visual performance/workload during helicopter flight under VFR.

Description of the Project:

Visual data obtained during the conduct of basic VFR helicopter maneuvers will be compared with similar data obtained in the 2B24 helicopter simulator and IFE helicopter flights. These performance data and their subsequent comparisons will provide an objective data base which will be useful in understanding pilot workload on different subtasks and pilot scan techniques as well as demonstrating potential cockpit panel design deficiencies.

Progress, Status and Results:

Two groups of subjects have been selected for the investigation. The recently graduated pilots have flown and their visual performance has been recorded. Data are still needed from the more experienced pilots before analyses can be completed. However, work related to this effort was presented at the Aerospace Medical Association Meeting under the title "Aviator Visual Performance: A Comparison Study of a Helicopter Simulator and the UH-1H Helicopter." Further, Work related to aviator oculomotor performance during IFR flight was presented at AGARD/ASMP and the Aerospace Medical Association meeting under the title, "Visual Performance/Workload of Helicopter Pilots During Instrument Flight."

Papers Published:

None.

Papers to Scientific Journals:

None.

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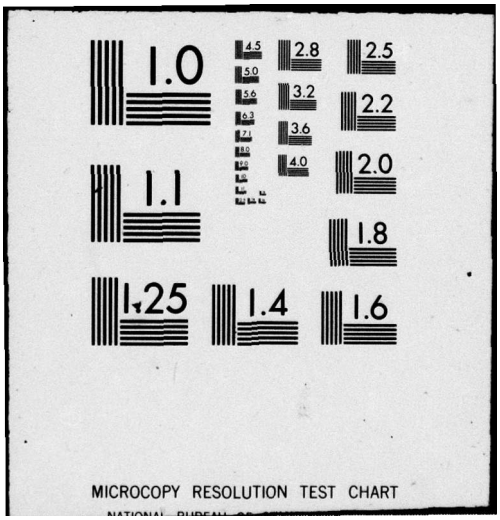
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MICROCOPY RESOLUTION TEST CHART

Visual Performance During Day Terrain Flight

Statement of the Problem:

During the Vietnam experience, The Army very rarely had to contend with surface-to-air weapons. With Small arms being the main threat, helicopters were flown at a high altitude until they reached their objective, completed their mission, and returned home at the same high altitude. However, with the threat of Russian surface-to-air weapons the Army now has developed a tactical flight called Nap-of-the-Earth or NOE which basically utilizes the terrain for concealment to approach and leave their objective. Unlike normal flight profiles NOE work is conducted at very low altitudes and variable air speeds with the primary objective being concealment of the aircraft enroute to an assigned mission objective. The necessity of avoiding obstacles while assuring adequate height above terrain features and navigating to an objective while maintaining concealment places a formidable workload on the aviator. Much of the information necessary to perform this type of flight is processed through the visual modality. This sensory modality then could be considered the most critical for helicopter flights.

Description of the Project:

This research will be directed at determining where a pilot looks with his eyes during terrain flights. Subjects will be six Army aviators. Visual performance will be measured using the Eye Mark Recorder linked to a film camera. All pilots will perform NOE/low level flights. All film will be scored in the laboratory and time measurements of each position referenced on the windscreen will be obtained during the analysis of each flight.

Progress, Status and Results:

A protocol to perform this work has been reviewed and accepted. Data have been collected during both NOE and low level flights and data reduction has been completed. Presently, a technical report is being prepared for publication.

Papers Published:

None

Papers to Scientific Journals:

None.

Visual Work load of the Co-pilot/Navigator During Terrain Flight

Statement of the Problem:

The emphasis on aviator workload has been a primary concern to the US Army aviation community since the incorporation of low altitude terrain flight techniques into the helicopter tactics repertory. Navigation has been a particularly acute problem at low altitudes due to the relative perceptual speeds at which a terrain is traversed and the subsequent short periods of time that navigational cues remain in the visual field. The division of duties between the primary aircrew currently requires that the navigator/copilot perform duties which entail among other things, monitoring the map and navigation instruments as well as the terrain in an attempt to locate significant navigational cues needed for maintaining the correct flight path; monitoring helicopter engine instruments and other flight instruments; tuning radios; and orally providing navigational information to the pilot that will allow him to maintain the appropriate flight path. Thus, the navigator/copilot also encounters a large visual workload during low altitude flights.

Description of the Project:

This research will assess navigator visual performance via a modified NAC Eye Mark recording system used in conjunction with a high speed, LOCAM camera. Airspeed, altitude, and geographical location as well as other flight performance measures will be recorded via HIMS. Visual free time will be determined through performance of a nonflight related task. NOE flight will be required and successful location of the checkpoints will be noted as with other flight performance measures.

Progress, Status, and Results:

Data examining the visual workload of the navigator/copilot have been collected, analyzed and prepared for publication. Future research will examine the visual workload of the navigator/copilot during the utilization of experimental navigation at night with and without the use of the AN/PVS-5 night vision goggles.

Publication:

Visual workload of the copilot/navigator during rotary wing terrain flight, Sanders, M. G., Hofmann, M. A., Simmons, R. R., & DeBonis, J. N. USAARL Report No. 78-5.

Paper to Scientific Journal:

Visual workload of the copilot/navigator during rotary wing terrain flight, Sanders, M. G., Hofmann, M. A., Simmons, R. R., and DeBonis, J. N. Human Factors Journal, in press.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA 0G 0149	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	D. Change	U	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.27.73.A	3E162173A819	00	018
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)*

(U) Workload Assessment of Aircrews During Rotary Wing Flight

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

001300 Aircraft; 009400 Man-Machine Relations; 007500 Human Factors Engineering

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
77 10	Cont.	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: NA EXPIRATION:
b. NUMBER:*
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	3.5	123
	CURRENT 79	2.5	206

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory

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TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Laboratory Field Research and Biomedical Applications Division

ADDRESS:* Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* Kimball, K. A., Ph.D.

TELEPHONE: (205) 255-3211

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: Lees, M. A., CPT, MSC

NAME: Sanders, M. G., Ph.D.

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Military Aircraft; (U) Man-Machine Relations; (U) Human Factors Engineering; (U) Psychology; (U) Human Volunteers; (U) Recording Devices; (U) Bioengineering; (U) Stress Physiology; (U) Computers

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To provide US Army aviation with information with regard to the workload, both perceptual and psychomotor, experienced by rotary wing aircrews during the performance of various required tactical missions. Special emphasis will be placed on the objective quantification and interpretation of this workload data and its relation to variables such as present and future aircraft designs, displays, controls, task loading, mission types and aircrew physiological and psychological states.

24. (U) The approach will be directed at utilizing various state-of-the-art and special purpose in-flight recording systems and statistical techniques to quantify and predict aviator performance levels and subsequent man-system mission efficiency as a function of independent variables under test.

25. (U) 77 10 - 78 09. Two efforts completed in this area during FY 78 were the workload and performance assessments of a stability augmentation system and a concept evaluation of the AN/PVS-5 bifocal night vision goggles. Final reports were provided in both these areas. Two research papers were presented at the AGARD/ASMP conference and the Aerospace Medical Association meeting during FY 78 concerning these areas. As well, USAARL Report No. 78-14 and TRADOC Concept Evaluation Final Report entitled "Evaluation of the Focusing Concept with the AN/PVS-5 Night Vision Goggles" were completed. This research was also submitted and accepted for presentation at the Human Factors Society meeting in October 1978. The article entitled "An Evaluation of Perceptual-Motor Performance During a Helicopter Hover Maneuver" was accepted for publication in the Human Factors Journal.

*Available to contractors upon originator's approval.

DD FORM 1 MAR 66 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE.

Aviator Performance During Day and Night Terrain Flight

Statement of the Problem:

The objective of this research is to determine what effects on aviator performance during terrain flight are introduced by the application of the night vision goggles (NVG) as a primary viewing device. Performance of aviators during low level (LL) and nap-of-the-earth (NOE) flight profiles using NVG's will be compared to similar profiles flown during the day and night using only the unaided eye.

Description of the Project:

Previous experience with Army aviation has emphasized the tactical requirement in achieving 24-hour capability in the development of the aviator's ability to perform terrain flight profiles during both day and night operations. One device developed to aid in the accomplishment of this requirement is the AN/PVS-5 Night Vision Goggles (NVG's). The night vision goggles were originally developed for ground use but are now considered to be an interim solution to aid the pilot's night vision. Currently, little information is available which describes the effect of night vision goggles on aviator performance. This project seeks to improve the inhouse data base being developed as a result of an ongoing research program designed to evaluate the effects of night vision goggles on rotary wing aviator performance. Performance data obtained from two earlier investigations of terrain flight, one using the night vision goggles and one using the unaided eye during the day and night, will be utilized for this investigation. Appropriate flight profiles will be identified and standardized across the two studies. Multivariate analysis techniques will be used to test for significant differences between NFG's flight and flights using the unaided eye for both Low Level and Nap-of-the-Earth flight profiles. In addition, the analysis will designate those measures of between visual conditions.

Progress, Status and Results:

Research in this area has been delayed due to efforts required on higher priority research and manpower limitations.

Papers Published:

None

Papers to Scientific Journals:

None

Operational Measures of Pilot Performance During Autorotations

Statement of the Problem:

The objective of this study is to investigate pilot and aircraft performance as related to autorotational maneuvers.

Description of the Project:

Currently, autorotation is the only inflight escape system available to the helicopter pilot. For this reason, research into mechanisms which affect this maneuver is very important. Preliminary investigations into accident data records show that a significant number of problematic landings associated with this maneuver could be attributed to human factor errors, leaving the question of what factors are associated with such pilot performance. This study is conducted in two phases. Phase I involves a review of autorotational accidents. Information derived from these reports will provide cost figures and should yield information as to variables common to various types of aircraft, weather conditions, and time of day which may be contributory factors to these accidents. Phase II will involve measureing both pilot and aircraft performance during autorotation. Initial variables to be studied relative to performance during autorotation will include environmental conditions and individual differences.

Progress, Status and Results:

Autorotational accidents for FY 70-72 have been analyzed. A technical report detailing these accidents has been written (USAARL Report No. 74-2 entitled, "Army Autorotational Accidents FY 70-72"). Necessary equipment for measuring autorotational performance has been developed, and preliminary flight tests have been performed. A protocol to accomplish this research is being prepared.

Papers Published:

None.

Papers to Scientific Journals:

None.

Visual Performance During Night NOE and Low Level Flight

Statement of the Problem:

The objective of this investigation is to examine the visual information requirements (scan patterns, dwell times, viewing range, etc.) of Army aviators while performing night Nap-of-the-Earth and low level flights.

Description of the Project:

In contrast to day NOE flight, where the aviator is constantly flooded with many perceptual cues, night NOE work places the aviator in an environment where normal cues are degraded or deteriorated to such an extent that they possibly lose their normal value. For example, it has been demonstrated through classic laboratory research that as luminance levels deteriorate, it becomes increasingly difficult for the human eye to perceive detail, delineate texture, or retain good depth perception. These cues are of extreme importance for NOE/low level flight and deterioration in efficient aviator performance may well be evident as such cues are more difficult to perceive. This work will seek to determine if changes in visual scanning techniques result as a function of decreased luminance levels. If performance is maintained at a satisfactory level for NOE flight with less visual information, and visual scanning patterns are similar for both day and night operations, this information will be of value in determining just what the critical perceptual cues are for optimally performing this type of flight profile. This study will utilize six Army aviators. Visual performance will be measured using a corneal reflection technique in conjunction with a 16mm motion picture recording system. The windscreen will be divided into eight sectors and there will also be marked two chin bubble sectors, two side door sectors and one inside cockpit sector. The six aviators will fly both low level and NOE runs and will be required to make two flights. (NOE flights will be a riverbed; negating the navigation task.) The motion picture data will be analyzed with regard to time spent in each sector, transitions in and out of each sector, and percentage of time spent in each sector's viewing ranges, etc.

Progress, Status and Results

Investigation of formerly proposed techniques, including low light level TV and video recordings, have been assessed and determined to be inadequate. Further modifications to the equipment have been accomplished. The present approach will include the utilization of the Eye Mark recorder, LOCAM motion picture cameras, high speed film and a light intensifier system. Tests of the light intensification system demonstrate that night visual performance research can be accomplished with a high degree of clarity and

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no interference with the subject. The project is delayed due to work on higher priority research.

Papers Published:

None.

Papers to Scientific Journals:

None.

Visual Performance During Night Helicopter Flight

Statement of the Problem:

The primary objective of this project is to obtain data of pilot's visual performance/workload during night helicopter flight.

Description of the Project:

Evolving from the Army's modern air mobility concept, the helicopter has become a strategic element of the tactical structure. Although audio and tactical stimuli are utilized, the pilot still relies in large measure on visual information to maintain aircraft stability and safe flight. This information, under visual flight rules (VFR), is obtained from sources within the cockpit as well as outside the aircraft. However, when flying under instrument meteorological conditions (IMC) or restricted visibility such as night, more if not all, cues required for appropriate aircraft control and management must be gained from the information provided on the aircraft instrument panel. The purpose of this project is to provide information relative to the visual performance and workload of pilots during helicopter flight under night conditions. Ten Army aviators of varying experience will participate in helicopter flights under night conditions. Visual performance will be measured with a modified NAC Eye Mark recorder used in conjunction with a LOCAM high speed camera. Visual free time will be measured with a free time monosyllable chart. Altitude will vary from ground hover to cruise flight at five thousand feet.

Progress, Status and Results:

Techniques utilizing video low light level cameras and infrared photograph film have proven inadequate to record visual performance during night helicopter flights. Tests of the light intensification system demonstrate that night visual performance research can be accomplished with a high degree of clarity and no interference with the subject. The project is delayed due to work on higher priority research.

Papers Published:

None.

Papers to Scientific Journals:

None.

Pilot Visual Performance During Simulated Instrument Flight

Statement of the Problem:

This is the first of a series designed to extend our present data base, compare the fidelity of the 2B24 simulator to the real world, and compare that of simulation in general. The current project concentrates on visual performance during instrument flight in a helicopter simulator.

Description of the Project:

The helicopter has become an integral part of the tactical structure and is continuing to receive expanding messions. Mission accomplishment in a safe and efficient manner is dependent in large measure on visual information. This information under visual flight rules (VFR) can be gained from sources within the cockpit as well as viewing the outside world. On the other hand, when flying under instrument meteorological conditions (IMC), all cues required for appropriate aircraft control and management must be gained from inside the cockpit. This study will provide data with regard to the critical visual cues used during simulated instrument flight. Such data are vital for optimal design and information transfer in the helicopter environment. Ten rotary wing aviators of varying experience will participate in simulated aerial flights in the 2B24 Synthetic Flight Trainer. Visual performance will be recorded via a modified NAC Eye Mark recorder in conjunction with a 16mm motion picture camera with time code capability

Progress, Status and Results:

Eye movement data have been acquired from aviators of varying experience levels. Preliminary results indicate that aviators spend 68% to 70% of their total visual time, during IFR flight, monitoring two of the twenty-three instruments. The final report was presented at the NATO/AGARD Aerospace Medical Panel specialist's Meeting, Fort Rucker, Alabama, May 1978. In addition, to providing objective data which demonstrated the similarity of the visual workload comparison between the UH-1 flight simulation and the UH-1 helicopter; the visual performance data expanded the US Army Aeromedical Research Laboratory's visual data base.

Papers Published and Presented:

Simmons, R. R., Kimball, K. A., and Diaz, J. J. "Methodological Considerations of Visual Workload of Helicopter Pilots." Paper presented at the

NATO/AGARD Aerospace Medical Panel Specialists' Meeting, Cologne, Germany, April 1977.

Simmons, R. R., Kimball, K. A., and Diaz, J. J. Measurement of Aviator Workload During Helicopter Operations. USAARL REPORT 77-4, December 1976.

Papers to Scientific Journals:

None.

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RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION	2. DATE OF SUMMARY	REPORT CONTROL SYMBOL
DA OE 6734	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY	6. WORK SECURITY	7. REGRADING	8. DISB'N INSTR'N	9. SPECIFIC DATA-CONTRACTOR ACCESS	10. LEVEL OF SUM
77 10 01	D. CHANGE	U (No Ch)			NL	[X] YES [ ] NO	A. WORK UNIT

10. NO. CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.42.07E	4E464207D425		283
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code): (U) Development of Measurement Techniques for the Medical Assessment of Visually Coupled System (VCS) Components

12. SCIENTIFIC AND TECHNOLOGICAL AREAS: 004000 Components; 001400 Aircraft Flight Instrumentation (Helicopter); 007500 Human Factors Engineering; 007400 Bioengineering

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
7509	7909	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER: N/A

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	2	67.
	CURRENT 79	1	65.

19. RESPONSIBLE DOD ORGANIZATION

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TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

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NAME: KIMBALL, Kent A., Ph.D., DAC

TELEPHONE: (205) 255-3211/6504

SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: VERONA, R. W., CPT

NAME: DUNCAN, Chester, CPT

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code)

(U) Visually Coupled System, (U) Helmet Mounted Sight, (U) Helmet Mounted Display

23. TECHNICAL OBJECTIVE. 24. APPROACH. 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To develop measurement techniques for the medical assessment of Visually Coupled System (VCS) components.

24. (U) It is possible to inadvertently compromise an aviator's safety and physiological performance when designing and fabricating a VCS. Therefore, the VCS hardware must be scrutinized carefully to insure mutual man-machine conformity. The first phase of the study will be concerned primarily with the Helmet Mounted Sight (HMS) component of the VCS. The approach during this phase will be to conduct laboratory and flight tests to determine the aiming/tracking capabilities of a crewmember using head orientation. The effects of eye dominance, helmet suspension, helmet weighting and target speed on accuracy will also be investigated. The second phase will be focused on the assessment of helmet mounted displays (HMD). Factors such as display color, image quality and size, brightness, contrast and their impact on the visual system of the crewmember and consequent performance will be investigated.

25. (U) 77 10 - 78 09. A low light level television system (LLLTV) mounted on a UH-1M (INFANT) aircraft can now be aimed with head movements using a helmet mounted sight (HMS) and the LLLTV video can be viewed on a helmet mounted display (HMD). This completes the VCS installation. A data acquisition system package for the phase 2 flight test is being integrated and installed on the aircraft. This system will record video from the sensor and ten other analog parameters including aircraft heading, radar altitude, airspeed, relative position, and subjects head aiming direction. A symbology generator is also being checked out and programmed for later installation on the aircraft. The test plan for the phase 2 test is being modified to address specific questions posed as the Integrated Helmet and Display Sight System (IHADSS-a VCS) design matures for the YAH-64 Advanced Attack Helicopter.

*Available to contractors upon originator's approval

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Development of Measurement Techniques for the Medical Assessment of Visually Coupled System (VCS) Components

Statement of the Problem:

It is possible to inadvertently compromise an aviator's safety and physiological performance when designing and fabricating a VCS. This is because of the intimate and delicate interface which exists between the man and the machine in a VCS. This research program is to provide a scientific data base for government and industry helmet mounted sight (HMS) and helmet mounted display (HMD) parameters and configurations to the human's psychomotor and perceptual capabilities and limitations.

Description of the Project:

In the first phase of the research program head aiming/tracking performance in a vibration environment was investigated. It was determined that target speeds significantly affected aiming/tracking performance, and although eye dominance was also statistically significant too, the performance difference was negligible compared to target speed differences. Helmet weighting and suspension did not affect aiming/tracking performance in a reliable manner. This information impacted the design of the HMS being incorporated into the YAH-64 Advanced Attack Helicopter.

The second phase of the program involves an analysis of the HMD. The display color, contrast, luminance, persistence, image quality, field-of-view (FOV), and see-through capability can have a significant effect on viewer fatigue and visual performance. Since these parameters are interactive, acquired laboratory measurements are used to select a series of candidate displays for airborne experimentation in a VCS. The pilotage, navigation, and target acquisition performance and laboratory physical display and visual performance measures will be used to determine optimum display characteristics for specific tasks and ambient conditions.

Progress, Status and Results:

A low light level television system (LLLTV) mounted on a UH-1M (INFANT) aircraft can now be aimed with head movements using a helmet mounted sight (HMS) and the LLLTV video can be viewed on a helmet mounted display (HMD). This completes the VCS installation. A data acquisition system package for the Phase II flight test is being integrated and installed on the aircraft. This system will record video from the sensor and 10 other analog parameters including aircraft heading, radar altitude, airspeed, relative position, and subject's head aiming direction. A symbology generator is also being checked out and programmed for later installation on

the aircraft.

The test plan for the Phase II test is being modified to address specific questions posed as the Integrated Helmet and Display Sight System (IHADSS--a VCS) design matures for the YAH-64 Advanced Attack Helicopter. The UH-1M (INFANT) test bed aircraft has been used to support three 1-week miniflight tests to aid in maturing the IHADSS design. Feedback from these miniflight tests is being used to modify the Phase II flight test plan.

The laboratory portion of the Phase II test has been devoted to obtaining image quality measures from miniature cathode ray tubes (CRT) used in HMD, and determining the effects of different optical combiner properties on the image quality. Chromatic aberrations occur when CRT phosphors other than pure green are used with the collimating optics. Techniques are being developed to measure the effects of combiner coatings on apparent contrast and conspicuity of the displayed information on see-through displays.

List of Publications:

Verona, R. W. Head Aiming/Tracking Accuracy in a Helicopter Environment. USAARL Letter Report 78-10-7-5, March 1978.

Papers to Scientific Journals:

None

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DA0B6896	781001	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
771215	H. Termination	U	U		NL	[X] YES [ ] NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.11.01.A	3A161101A91C	00	289
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)* (U) Electromyographic analysis of msucle stresses induced by whole body vibration and asymmetric headloads

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 002400 Bioengineering; 013300 Protective Equipment; 016200 Stress Physiology; 001300 Aircraft

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10		DA	C. In-House

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: N/A EXPIRATION:
b. NUMBER:*
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	2.4	57
FISCAL YEAR CURRENT 79	0	0

19. RESPONSIBLE DOD ORGANIZATION
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SOCIAL SECURITY ACCOUNT NUMBER:
ASSOCIATE INVESTIGATORS
NAME: HALEY, J. L., GS-14
NAME: LEWIS, James A., GS-11

21. GENERAL USE

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Vibration; (U) Electromyography; (U) Muscle Stress; (U) Fatigue; (U) Human Factors; (U) Instrumentation; (U) Headload; (U) Helmet

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) 1. To develop a reliable, sensitive and quantitative technique for evaluating muscular activity and fatigue. 2. To determine the effect of whole body vibration and head load on muscular stress in the neck and back of human subjects.

24. (U) Field conditions which expose humans to whole body vibration and require protective headgear will be simulated in the laboratory. Computer processed surface electromyograms will be used as muscle stress indicator to compare fatigue producing characteristics of protective headgear and auxillary helmet mounted devices.

25. (U) Data gathered during FY 77 was analyzed and the results of the studies on comparative techniques of analysis for EMG data and the study of muscle stresses induced by helmets of the PASGT system were published. A technique was developed which quantifies the vibration elicited muscle synchronization due to the tonic vibration reflex. The technique requires the calculation of the autocorrelation function for EMG data and yields the relative magnitude of total muscle activity compared to magnitude of activity which is due to vibration. During the initial development of this technique the autocorrelation function was calculated by an SEL 85 computer from tape recorded data. An analyzer having the capability of performing the calculation in real time has been purchased for application of the technique to performance studies and for basic research into the closed loop dynamic response of the muscles to vibration. A paper describing the analysis method is being written for publication.

*Available to contractors upon originator's approval.

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Electromyographic Analysis of Muscle Stresses Induced by Whole Body Vibration and Asymmetric Headloads

Statement of the Problem:

In order to make medical recommendations concerning muscle stress produced by mechanical systems within the Army inventory, a method of quantifying muscular stress is required. It is the intent of this project to provide such a technique.

Description of Project:

Mechanization in the military environment has produced a unique variety of muscular stresses on the soldier. In order to maximize the effectiveness of the soldier in the field, it is necessary to minimize the muscular fatigue to which he is subjected. It is also necessary to minimize those factors such as vibration which may produce decrements in his ability to control complex and sensitive military weapons systems, devices or equipment. Before such neuromuscular effects can be minimized, one must develop a technique with which to quantify or determine their psychophysiological origin. This project was undertaken with that objective in mind. The technique of electromyography is being used to quantify several aspects of muscular performance. First, the technique is being used to differentiate between the levels of muscular stress produced by prototype systems (E.G., helmets, seats, etc.) which are being used in the Army. Secondly, the technique is being used to study the basic response of the neuromuscular system to environmental vibration. Lastly, the technique will be applied to the measurement of muscular fatigue and its rate of onset. Raw electromyographic data (bioelectric muscle potentials) are amplified using sensitive electronic equipment. Following this they are processed both in the time domain and in the frequency domain to yield indices which reflect level of muscular stress, periodicity induced by vibration, and nature of the muscular activity whether gross or fine.

Progress, Status and Results:

A comparison of several methods of analysis for electromyographic data was performed and published in Aviation, Space and Environmental Medicine. The results of the study indicate that the optimum and most easily implemented EMG parameter for indicating muscle stress is the root-mean-square (RMS) value of the electromyographic data. Determination of peak amplitude histograms may be useful in differentiating between and fine and course motor

control. The commonly used technique of total integrated EMG is the equivalent of the root-mean-square determination and may be used where more readily implemented with instrumentation on hand. The time constant of the integrator used was not a factor in determining the linearity of the EMG versus muscle stress curve. With this study as a background, an evaluation of muscle stress produced by two helmets of the Personal Armor System for Ground Troops (PASGT) was conducted. Statistically significant differences were found and reported to the system developer at a Test/Integration Working Group meeting. These quantitative muscle stress data were weighed against differences in ballistic protection afforded by each helmet in selecting one of the candidate helmets as a replacement for the M-1 helmet. In a third study, it was determined that the autocorrelation function, when applied to electromyographic data, provided a means of quantifying the level of syncronization induced in a muscle by environmental vibration (i.e., from a control handle). The technique was presented at the Annual Scientific Meeting of the Aerospace Medical Association, May 1978. While this method requires further standardization and evaluation it appears to offer a definitive means of correlating vibration exposure with fine motor control and performance. A Real Time Spectrum Analyzer was purchased in order to further refine and explore this technique. Preparation of a manuscript describing this technique is in preparation. A request for proposal (RFP) was drawn up for the purpose of determining the relationship between vibration and fine motor control. As yet no suitable proposals have been received. It is likely that the work will be done in-house.

List of Publications:

Johnson, J. Comparison of Analysis Techniques for Electromyographic Data, 1978, USAARL Laboratory Report.

Johnson, J. Vibration Elicited Muscle Synchronization, presented at the Annual Scientific Meeting of the Aerospace Medical Association, New Orleans, LA, May 1978.

Papers to Scientific Journals:

Johnson, J. Comparison of Analysis Techniques for Electromyographic Data, Aviation Space and Environmental Medicine, 1978, 49 14-18.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
	78 10 01	DD DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 17	H. Termination	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.22.09A	2T262209AH76	AMRTL	053
b. CONTRIBUTING	6.27.73A	3E762173A819	00	018
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)*

(U) Helicopter Flight Imagery: Eye and Head Movement

12. SCIENTIFIC AND TECHNOLOGICAL AREAS* 001300 Aircraft; 004200 Computers; 009400 Man-Machine Relations; 013400 Psychology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
77 11	78 11	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:* NA

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE	a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR PRECEDING 78	1.5	64
FISCAL YEAR CURRENT 79	-0-	0

19. RESPONSIBLE DOD ORGANIZATION

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20. PERFORMING ORGANIZATION

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Fld Rsch & Biomed Appl Divisions

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SOCIAL SECURITY ACCOUNT NUMBER:

ASSOCIATE INVESTIGATORS

NAME: SIMMONS, R. R., DAC

NAME: SANDERS, M. G., Ph.D.

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Flight Simulators; (U) Rotary Wing Aircraft; (U) Human Factors Engineering; (U) Psychology

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) This work will provide visual workload data which will be utilized to determine the flight imagery requirements for a high fidelity visual display system for the AMRL Helicopter Research Similator. Further, it will increase the technical data base on pilot visual workload during tactical helicopter flight.

24. (U) Approach will be to obtain visual workload data via Eye NAC film recording during in-flight maneuvers; analyze these data with respect to eye movement speeds, dwell times, scan patterns and human oculomotor limits.

25. (U) 77 10 - 78 09. Progress under this work unit is reflected by the development of programs to process and analyze both head and eye movement with the SEL 8500 computer. The data have been collected and analyzed. A final report is currently being written.

*Available to contractors upon originator's approval.

DD FORM 1 MAR 68 1498 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE. DD FORMS 1498A, 1 NOV 65 AND 1498-1, 1 MAR 68 (FOR ARMY USE) ARE OBSOLETE

Helicopter Flight Imagery: Eye and Head Movement

Statement of the Problem:

The progress that the US Army Aeromedical Research Laboratory has made in the recording and analyses of visual performance in a helicopter environment has led to a contractual joint effort between USAARL and USARTL to attempt to record head and eye information. This effort was needed for a flight simulator being developed by USARTL.

Description of the Project:

The project was designed to complete the Field Research and Biomedical Applications Division's responsibility to collect and analyze data to provide information needed in defining visual requirements for a nap-of-the-earth helicopter flight simulator visual system. The purpose of such effort was to attempt to define the trade-offs involved in head/eye movements and tracking/switching mechanization that might be used to implement resolution shifting and/or area of interest in USARTL's simulator visual system.

Progress, Status and Results:

Progress under this work unit is reflected by the development of programs to process and analyze both head and eye movement with the SEL 8500 computer. The data have been collected and analyzed. A final report is currently being written.

Papers Published:

None.

Papers to Scientific Journals:

None.

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DAOG 0149	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8A. DISP'N INSTR'N	8b. SPECIFIC DATA - CONTRACTOR ACCESS	9. LEVEL OF SUM
78 02 01	H. Term	U	U	NA	NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	6.65.707	665.707.985	00	052
b. CONTRIBUTING	6.27.73.A	3E162773A819	00	018*
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)*

(U) Increased Night Flight Capabilities/Integrated Night Vision Goggles Display (OC 6886)

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*

001300 Aircraft, 009400 Man-Machine Relations, 013400 Psychology

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
78 02	80 02	DA	C. In-House

17. CONTRACT/GRANT

a. DATES/EFFECTIVE: EXPIRATION:

b. NUMBER:*

c. TYPE: d. AMOUNT:

e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 78	1	44
	CURRENT 79	0	0

19. RESPONSIBLE DOD ORGANIZATION

NAME:* US Army Aeromedical Rsch Laboratory

ADDRESS:* Fort Rucker, AL 36362

RESPONSIBLE INDIVIDUAL NAME: Knapp, Stanley C., COL, CDR

TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION

NAME:* US Army Aeromedical Research Lab

ADDRESS:* Field REsearch And Biomedical Applications Division
Fort Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)

NAME:* Kimball, K.A., Ph.D.

TELEPHONE: (205) 255-3211

SOCIAL SECURITY ACCOUNT NUMBER

ASSOCIATE INVESTIGATORS

NAME: Sanders, M.G., Ph.D.

NAME: Glick, D. D., MAJ

21. GENERAL USE

Foreign Intelligence Considered

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Military Aircraft; (U) Man-Machine Relations; (U) Displays; (U) Recording Devices; (U) Night Vision Goggles; (U) HFE

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To determine the feasibility of integrating miniature LED's into the AN/PVS-5 Night Vision Goggles mask which will provide the pilot aircraft status data during the flight.

24. (U) Approach will be to design and integrate the display into a standard pair of AN/PVS-5 goggles, perform a static photometric evaluation of the device and initiate flight evaluations which will provide aviator and aircraft performance data utilizing the modified night vision device.

25. (U) None.

*CEP funds provided by USAAVNS, TRADOC

*Available to contractors upon originator's approval.

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RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY

1. AGENCY ACCESSION*	2. DATE OF SUMMARY*	REPORT CONTROL SYMBOL
DAOB6902	78 10 01	DD-DR&E(AR)636

3. DATE PREV SUM'RY	4. KIND OF SUMMARY	5. SUMMARY SCTY*	6. WORK SECURITY*	7. REGRADING*	8a. DISP'N INSTR'N	8b. SPECIFIC DATA-CONTRACTOR ACCESS	9. LEVEL OF SUM
77 10 01	H. Terminate	U	U		NL	☒ YES ☐ NO	A. WORK UNIT

10. NO./CODES:*	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a. PRIMARY	61101A	3A161101A91C	00	292 J2111517 AR
b. CONTRIBUTING				
c. CONTRIBUTING				

11. TITLE (Precede with Security Classification Code)* (U) Saturated Heated Oxygen/Bleed Air Nebulizer for Resuscitation of Thermal Casualties in Air Evacuation

12. SCIENTIFIC AND TECHNOLOGICAL AREAS*
001300 Aircraft 016200 Stress Phys

13. START DATE	14. ESTIMATED COMPLETION DATE	15. FUNDING AGENCY	16. PERFORMANCE METHOD
76 10	78 09	DA	C. In-House

17. CONTRACT/GRANT
a. DATES/EFFECTIVE: EXPIRATION:
b. NUMBER:*
c. TYPE: d. AMOUNT:
e. KIND OF AWARD: f. CUM. AMT.

18. RESOURCES ESTIMATE		a. PROFESSIONAL MAN YRS	b. FUNDS (In thousands)
FISCAL YEAR	PRECEDING 1978	4.0	155
	CURRENT 1979	0	0

19. RESPONSIBLE DOD ORGANIZATION	035550	01

NAME:* MRDC Aeromedical Research Lab
ADDRESS:* P. O. Box 577, Ft Rucker, AL 36362

RESPONSIBLE INDIVIDUAL
NAME: KNAPP, S. C., COL, Cdr MD 12
TELEPHONE: (205) 255-5107

20. PERFORMING ORGANIZATION	035553	01

NAME:* MRDC Aviation Medicine Research Div, Aeromedical Research Lab
ADDRESS:* Ft Rucker, AL 36362

PRINCIPAL INVESTIGATOR (Furnish SSAN if U.S. Academic Institution)
NAME:* PETTYJOHN, F. S., COL DA
TELEPHONE: (205) 255-4610
SOCIAL SECURITY ACCOUNT NUMBER:

21. GENERAL USE
F.I.C. YES
21A. B. C. D. E.

ASSOCIATE INVESTIGATORS
NAME: DENNISTON, J. C., MAJ
NAME: POLLARD, G. D., CPT

22. KEYWORDS (Precede EACH with Security Classification Code) (U) Aircraft; (U) Clinical Medicine; (U) Aeromedical Evacuation; (U) Thermal Physiology

23. TECHNICAL OBJECTIVE,* 24. APPROACH, 25. PROGRESS (Furnish individual paragraphs identified by number. Precede text of each with Security Classification Code.)

23. (U) To develop and test the concept of use of heated saturated oxygen/bleed air in helicopter air evacuation/resuscitation of the hypothermic or pulmonary casualty.

24. (U) Develop new technology and equipment to use helicopter bleed-air and electrical power 23VDC or 115VAC 400 Hz to provide a source of heated, dry, or super-saturated oxygen or air to deliver heat to the hypothermic combat casualty. The concept of the lungs as a heat exchanger employing the extremely large surface area available for the passage of blood as a distributor of heat to distal organs represents a unique application in air evacuation and resuscitation. The equipment will be designed for simplicity, low cost, and compatibility with UH-1H aeromedical helicopters. Compatibility with advanced oxygen systems (chlorate candle and Army molecular sieve oxygen generators) will be explored. Concept and prototype evaluation will be conducted using mongrel dogs as subjects. Monitoring of temperature and pulmonary effects of increased inspiratory air/oxygen during simulated and in-flight evacuation missions will be accomplished.

25. (U) Studies of UH-1H bleed-air demonstrate adequate flow and temperature to provide inhalation rewarming of the hypothermic casualty. Qualitative contaminant analysis by infrared and mass spectroscopy indicate carbon monoxide (CO), sulfur dioxide (SO^2), and ammonia (NH^3) are present. Worst case occurs during ground idle (4 PPM CO, 14 PPM SO^2). Animal model for clinical evaluation with two prototype delivery systems for heated bleed air/oxygen has been developed.

*Available to contractors upon originator's approval.

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